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IMPACT OF VIDEOCONFERENCING ON THE DEMAND
FOR AIR TRAVEL

MATTHIAS METTE

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MATTHIAS METTE

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ABSTRACT

Videoconferencing is widely seen as the form of modern telecommunications having the largest potential to impact the growth of business air travel demand. Most existing studies focus on the substitutional effect of enhanced telecommunications on air travel and suggest different substitution estimates that diminish future business air travel growth rates. However, this research reveals that reasonable and convincing theoretical arguments exist supporting the complementary interaction of modern telecommunications and business travel.

A critical assessment of previous studies in this field shows that most research lacks sound empirical evidence. Besides this major deficiency, the thesis also recognizes other areas in need of future research efforts and identifies the potential for the airline industry to minimize the adverse impacts of modern telecommunications on its business and to benefit from the capability of these technologies to complement air travel.

In this study, the discussion and analysis of empirical data and observations are focused on the U.S. domestic and U.S. international market. Nevertheless, research findings regarding potential interactions between videoconferencing and business air travel, main implications of these relationships for the aviation industry, potential responses by airlines, and future research opportunities are applicable on a global basis.

A key component of the thesis is an industry-wide field survey carried out primarily among companies of the "Fortune 500" industry group on the characteristics of videoconferencing use and the actual and expected impact on corporate travel needs. From assessments made by videoconferencing managers and individual users of videoconferencing in these companies, it was possible to identify (1) characteristic videoconferencing adoption patterns, (2) main user groups and business purposes, (3) the role of travel substitution in the investment justification, (4) actual and projected impacts on business air travel patterns, and (5) perceived benefits and limitations of videoconferencing for business applications in economical, technical, social and communicational terms. Together with previous research findings, the results of this survey are used to construct a coherent picture of the present state of research in this field, considering all potential and observed interactions between both modes.

Thesis Supervisor: Prof. Robert W. Simpson
Title: Director, Flight Transportation Laboratory
Professor of Aeronautics and Astronautics

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ABBREVIATIONS

AEA:	Association of European Airlines
ATA:	Air Transport Association of America
BRI:	Basic Rate Interface
FAA:	Federal Aviation Administration
GDP:	Gross Domestic Product
IATA:	International Air Transport Association
ISDN:	Integrated Service Digital Network
ITCA:	International Teleconferencing Association
ITU:	International Telecommunications Union
kbps:	Kilo bits per second
LAN:	Local Area Network
Mbps:	Mega bits per second
MCU:	Multipoint Control Unit
NASA:	National Aeronautics and Space Administration
NTPSC:	National Transportation Policy Study Commission
PRI:	Primary Rate Interface
RPM:	Revenue Passenger Mile

1 INTRODUCTION

1.1 Research Problem

Telecommunications and transportation are essential for the functioning of the economic and social system, since they facilitate the making and developing of relationships. However, they are not only complementary technologies, because as a means of communication, they also compete. The recent development in telecommunications, especially of their most enhanced form, videoconferencing, constitutes a challenge to the transportation sector, particularly the airline industry.

Videoconferencing is widely seen to have a significant potential as a substitute for business air travel. In several regions of the world, its challenge might be higher than that of high-speed rails, which are now competing with short-haul air traffic in Western Europe. Videoconferencing and other teleconferencing applications are improving rapidly in technical and cost terms while the air transportation sector is experiencing congestion-related difficulties, at a number of locations, in maintaining its level of service attractive for business travelers. Therefore, the issue of videoconferencing as a substitute for air travel should be seriously considered in any long-term planning in the airline industry.

Corporate executives are today questioning the productivity of business travel and are exploring alternatives that also allow personal contacts but without the expense and particularly the loss of time associated with air travel. Videoconferencing offers the ability to conduct a business meeting between people located in different places without their having to travel to a common site; and, its quality is improving rapidly. Today, the participants of a videoconference mostly gather in specially equipped rooms at a designated time. From there, business is conducted using large television screens, fax machines, and increasingly computer data transfers. Advanced video technologies (roll-about units, and PC-desktop-videoconferencing) are now enhancing the popularity and use of videoconferencing. Meetings through video can be conducted from one's own office at a more reasonable cost. In the coming years, a new push for less expensive desktop-videoconferencing is expected through rapidly advancing technology and less expensive units.

Nevertheless, studying the impact of videoconferencing on air travel must not neglect that modern telecommunications may enhance employee productivity and provide new business opportunities of wider geographical scope. As a consequence, time may be freed for other business trips not possible prior to the adoption to videoconferencing, and new needs of travel to retain business relationships may be generated. In the long term, teleconferencing and other uses of telecommunications may alter existing business trip patterns and generally modify the structure of air transportation demand.

The relationship between telecommunications and transportation has been discussed in the transportation literature for more than 20 years. The energy crises in the early 1970s prompted much of the initial research on the substitution of telecommunications for travel. As expected, there is little agreement on the current and future impact of modern telecommunications on transportation primarily motivated by business travel needs.

Most research that has been done in this area focuses on urban and regional passenger travel, especially the journey to and from work (telecommuting). In the recent few years, more attention has been turned toward the specific analysis of the impact of enhanced telecommunications on inter-city travel and, therefore, air travel. However, as shown in this research, most existing studies have weaknesses in their approach and empirical support and are biased due to their exclusive orientation toward travel substitution.

The response of the aviation industry, both airlines and aircraft manufacturers, to some of the very recent studies shows that there is a considerable interest in understanding this effect better. The extent to which videoconferencing is substituting for, or stimulating, the face-to-face delivery of business services and, therefore, may affect the growth of business air travel, which represents the most lucrative segment of the airlines' market, is a particularly pertinent issue that has yet to be given sufficient research attention in relation to its importance.

There are also other interested parties who are keen in obtaining a better knowledge of this complex subject. Telecommunications vendors, exchange carriers, agencies and institutions would like to gain an insight into the extent of the impact of modern telecommunications on travel for market estimation purposes. Government agencies would like to know the effects on transportation carriers, services and infrastructure, as well as on energy consumption and environment.

1.2 Objectives of Research

The key objectives of this study are: (1) the recognition of potential interactions between modern telecommunications, particularly the most enhanced form, videoconferencing, and air travel demand; (2) the critical assessment of the existing empirical and analytical support for different hypotheses of interrelationships; and, (3) the identification of deficiencies in existing research and the recognition of areas for future research, where gaps in knowledge are evident, which should be filled if future air transportation planning is to be based on a sound footing.

Furthermore, short and long-term implications for the aviation industry are addressed, and potential responses by airlines to developments in the telecommunications area are suggested.

The discussion and analysis of empirical data and observations are limited in this study to the U.S. domestic market and the most important international business markets of the U.S. However, the research findings are widely applicable to telecommunications-air travel interactions in other parts of the world.

The study identifies current trends in business air travel demand and looks at factors underlying those, with a particular focus on the role of telecommunications. For this purpose, current developments in the videoconferencing area have to be explicitly analyzed. Videoconferencing adoption patterns, preferences in business communications, and the acceptance and appropriateness of videoconferencing for different business applications need to be identified. In addition, the study examines observations and evaluations by users and analysts as regards travel impacts. Also, the significance of travel substitution in the investment justification for corporate videoconferencing is a main research interest.

The study does not intend to develop completely new data and estimates related to the potential of videoconferencing to substitute for, or to stimulate, air travel demand. Instead, from the existing contributions to the literature, an attempt is made to construct a coherent picture of the current state of research.

Overall, the study provides an extensive and revealing picture of the present state of research and may serve as an effective basis for future research work. Its findings may become a starting point to refine future studies of the issue of telecommunications versus business air travel.

1.3 Study Methodology and Structure

The study of the impact of videoconferencing on air travel begins in section 2 with an analysis of the characteristics and trends of business air travel demand. Since a wide agreement exists that air travel for pleasure purposes does not seem to be susceptible to modern telecommunications, the business travel segment is the exclusive subject of the analysis. Current definitions of business air travel by trip purpose are addressed and historical data series interpreted. The discussion in this section stresses the continuous decline in the relative share of business air travel world-wide and the flat absolute growth rates of U.S. business air travel, and addresses the factors underlying these trends. The significance of substitute modes for the airline industry, as well as corporate travel budget trends monitored in different market surveys are analyzed.

Section 3 initiates with a basic introduction of video-teleconferencing systems and a discussion of the evolution of these technologies, focusing on the main drivers. Technical background knowledge is provided, and the continuously improving technical and price performance of videoconferencing is described. After discussing the videoconferencing market, its participants, and its future growth prospects, the characteristics of videoconferencing users are explicitly analyzed. Motivations for a videoconferencing investment, main business applications, established videoconferencing policies, as well as future plans as regards videoconferencing adoption and expansion are discussed. On the basis of existing user studies and own survey results, communication behavior and effectiveness of videoconferencing are compared with natural face-to-face communications. As long-term effects of videoconferencing, changes in the corporate structure and spatial characteristics of businesses are addressed. Finally, benefits and limitations of videoconferencing identified in existing research and by users in the survey for this thesis are analyzed.

Section 4 represents the main part of the study, specifically focusing on the interactions between enhanced telecommunications and business air travel. The section begins with a qualitative discussion of potential interrelationships between both modes identified in existing research and supported by user experiences. An essential component of this section is the critical assessment and interpretation of past studies, their approaches and results. In general, most of these studies heavily rely on speculative judgment and are not based on sound empirical or analytical methodologies. Afterwards, the role of travel substitution in the justification of a

videoconferencing investment is explicitly analyzed. The cost-benefit trade-off between videoconferencing and business air travel is assessed in different case studies by using a commercial software tool developed for such financial analyses.

This section also addresses evaluations by participants and analysts of the telecommunications and aviation industry as regards telecommunications-air travel interactions. The assessment of the airline industry is primarily gained from the survey of airframe manufacturers and international airlines carried out for the purpose of this study (survey forms, see Appendix 3 and 4). In addition, an extensive survey of users of videoconferencing in the business community -- primarily across corporations of the "Fortune 500" industry group -- was conducted for this thesis. The survey consisted of two parts: one designed for telecommunications and videoconferencing managers to receive assessments as regards videoconferencing and its impact on travel on behalf of a company (see Appendix 1), and another addressing this issue to individual business people in a company using videoconferencing (Appendix 2).

The survey focused on the identification of videoconferencing adoption patterns, main user groups and business purposes, the role of travel substitution in the investment justification, actual and projected impacts on business travel needs and patterns, and perceived benefits and limitations of videoconferencing for business applications in economical, technical, social and communicational terms. The survey findings are also compared with results of earlier studies and the trends and characteristics identified in those. Survey methodology and structure, recognized limitations of this empirical approach, as well as the demographics of the survey samples are addressed in section 4.5. Survey results as regards corporate travel budget trends are included in the discussion in section 2.4.2, while survey findings on videoconferencing user characteristics and motivations, adoption patterns, communication behavior and effectiveness, and perceived benefits and limitations of use are subject of the analysis in sections 3.6, 3.7, and 3.8. All other survey items directly addressing the interrelationship between videoconferencing and business air travel are part of the discussion and assessment in section 4.5.

The conclusions of this research are stated in section 5. The previous results are summarized and interpreted with respect to their implications for the aviation industry. Furthermore, potential responses of the airline industry to minimize adverse impacts on air travel demand and to benefit from the capability of modern telecommunications to complement air travel are addressed.

Finally, the significant deficiencies in the current research approaches and the extensive potential for future research in this field are discussed in section 6.

2 BUSINESS AIR TRAVEL

2.1 Characteristics of Business Air Travel

2.1.1 Definition of Business Air Travel

The total demand for air travel is usually disaggregated into pleasure (discretionary) and business (non-discretionary) travel. A further, more detailed subdivision of both categories is also widely applied. For the business travel segment, this breakdown by trip purpose and need respectively is discussed in the subsequent section 2.1.2.

Business travel involves a journey necessitated by one's employment and usually paid out of the firm's travel budget (Doganis 1991: 204). The latter fact can be seen as a main factor for a number of differences between pleasure and business air travel. Business travelers show a lower price sensitivity than discretionary travelers. Historically, the business travel segment is evaluated as price inelastic, meaning that any increase of air fares in real terms is associated with a less than proportional decline in business travel demand. However, this hypothesis has become increasingly controversial. Recession and increased global and domestic competition now cause companies to look for ways to cut costs and increase employee productivity. More stringent travel policies and tighter budgets are an apparent consequence.

These trends are responsible for a widely observed increased price sensitivity of business air travelers, as well as for an increased flexibility in meeting travel restrictions, e.g., advance purchase, or non-refundability, in order to save money. Arguing about the factors contributing to the capability of more flexible travel planning, causes people also increasingly to think about the role of modern telecommunications, particularly videoconferencing.

Moreover, the travel motivation has an impact on the frequency of travel, as well as on the average duration of a trip. Business travelers are more likely to be frequent users of air services. On the other hand, non-discretionary travelers, on average, also take shorter trips often without overnight stays, e.g., in the Northeast market of the U.S. or in several Intra-European markets. However, also for business travelers the rule applies that as journey distance increases so does the duration of an individual trip (Doganis 1991: 205-206).

In addition, business travelers have generally distinctive needs and expectations regarding in-flight service and comfort, the flexibility to change reservations and routings on short notice, high-frequency airline schedules, or quick check-in. For these needs, they are willing to pay higher prices. However, as said before, these are historically defined and observed attributes. Most recent studies have found that the nature of business travel is changing and not all the previous aspects have still their original significance for today's business air travelers.

2.1.2 Classification of Business Air Travel

After discussing general attributes and characteristics of business air travel, this category of non-discretionary air travelers should be further subdivided by travel purposes and motivations. In the literature, different ways for this disaggregation are suggested.

Based on survey data of D.K. Shifflet and Associates, Ltd., Apogee Research (1994: 3-7) subdivides business air travel into "group" and "transient" travel. Group travel is motivated by the participation in a group related function. The category comprises travel undertaken to participate in conferences, seminar and training sessions, and other group meetings (generally internal to the company). Transient travel, on the other hand, refers to trips that are not group related: to visit a client or to undertake a work assignment, for example. The category contains sales meetings, consulting, repair/service, government/military, stopover in-route, interviews, and other business.

The most recent data available for this thesis -- first seven months of 1993 -- show business air travel, as a percentage of total U.S. air travel, at 44.3% (Apogee 1994: 6-7). According to the data of D.K. Shifflet and Associates, Ltd., transient travel represents 53.2% of total U.S. business air travel with consulting being the largest transient travel segment (10.4% of total business air travel). In the category of group travel, all three types of meetings are almost similarly represented. Trips for the purpose of seminars and training show the highest share (17.2%). See Figure 2.1.2-1 for more detailed breakdown.

Another categorization of business air travelers is applied in a study by Arthur D. Little, Inc. (1991: 28-30). Here, the subdivision is made into intra-company air trips (carrying out operations, managing the company), non-company air trips (non-company meetings, consulting or other professional advice, and trips to sell a product or service), business air trips for conferences/conventions, business air trips

for training, and business air trips for other purposes. The breakdown of business purposes used in the questionnaire designed for this thesis is oriented on this subdivision employed by Arthur D. Little (see Appendix 1 and 2 and discussion in section 4.5). However, our categorization also contains two more segments, customer support/service (in the Arthur D. Little subdivision, part of non-company meetings) and interviewing (in the previous categorization, part of other business purposes).

The percentages of total business air travel for each segment are estimated on basis of data from the "1988 Survey of Business Travelers" conducted by the U.S. Travel Data Center. According to that, non-company trips clearly represent the highest portion of all U.S. business air travel (40% in 1988), whereas the shares of the other categories are similar at the order of 14-16%. Figure 2.1.2-1 also illustrates the detailed composition of this subdivision.

The data of the "1988 Survey of Business Travelers" also indicate that 43% of all business trips in the U.S. in 1988 involved air travel -- in absolute numbers: 66.9 million out of a total of 155.6 million business trips, while the average trip length for business air trips was cited as about 2,000 miles (Arthur D. Little 1991: 30-31).

Doganis (1991: 209) suggests to disaggregate the business travel segment not only by trip purpose but also by passenger needs. He distinguishes between routine and emergency business travel. The first category, for example, may involve a regular sales trip of a salesman from Boston to Japan, which is planned months in advance, while the latter kind of trip may be induced by the immediate need of a senior engineer to travel to another site of the company due to an unexpected major technical problem stopping production processes.

A categorization of business travelers can also be made in terms of their profession and seniority in a company (Doganis 1991: 206-207). Historically, business travelers have primarily been middle and senior managers and executives, as well as established lawyers, architects, consultants or other professionals. However, globalization of trade and competition, decentralization of companies, and the need of team work among dispersed locations at all management levels, together with the decline of real cost of air travel, have resulted in recent years in a growth of non-discretionary travel by more junior staff and skilled workers.

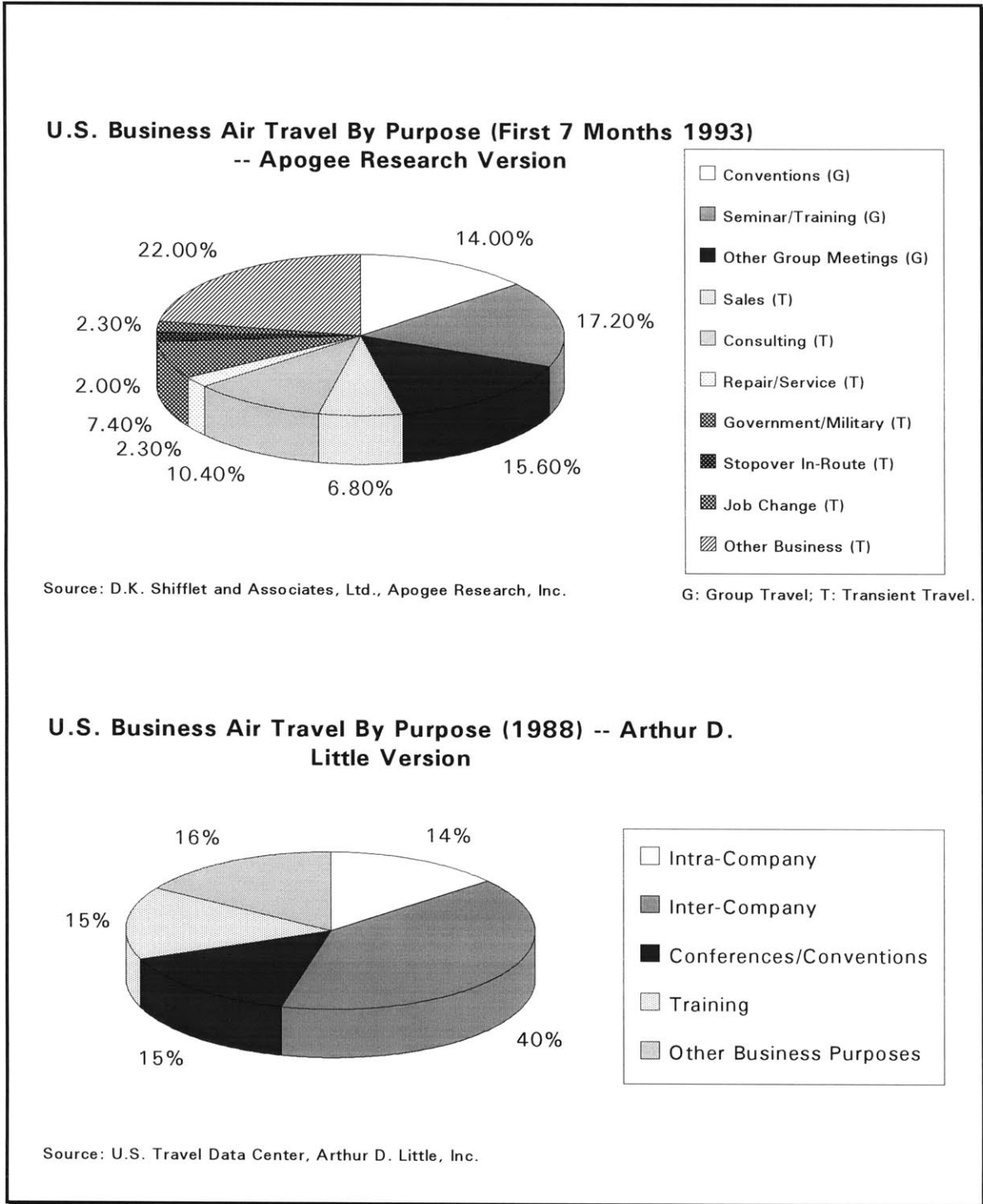


Figure 2.1.2-1: Composition of U.S. Business Air Travel by Trip Purpose

2.1.3 Determinants of Business Air Travel

In general, the demand for business air travel is modeled as a function of economic development, international trade, and growth of industrial globalization.

Parameters that can be used for such econometric modeling of business travel demand and its future growth projections are the following (Apogee 1994: 13):

- ↳ Employment
- ↳ Corporate Profits
- ↳ Gross Domestic Product
- ↳ Personal Consumption Expenditures
- ↳ Total Business Sales

Furthermore, the price of air travel has to be integrated in such econometric models, particularly with respect to the increasing price sensitivity of business air travelers. Average yield and full fare yield (coach class and business class) are generally assessed as appropriate proxies. How these parameters can be put into a functional relationship with business air travel demand is discussed in section 2.5.

2.2 Substitution Modes

The particular interest of the airline industry, but also of the transportation sector in general, in the role and significance of modern telecommunications is historically derived from the belief that telecommunications might substitute for certain types of passenger transportation.

Especially in Europe, the discussion of substitute modes for air travel has been focused for a long time on high-speed rail, whose infrastructure and services are continuously developing and which is increasingly competing with air transportation. However, high-speed rail is not only regarded as substitute but also as complement to the widely unprofitable short-haul air services in the Central and Western European region.

Besides high-speed rail, modern telecommunications, especially their most enhanced means, videoconferencing and associated computer conferencing applications, are widely seen as potential substitute modes for air travel, particularly some types of business air travel. Enhanced telecommunications are capable of offering an increasingly attractive price-performance alternative to business air travel, providing the same form of interactive face-to-face communication for which air travel is primarily used by business travelers.

However, the relationship between enhanced telecommunications and business travel is much more complex and certainly not limited to a simple trade-off, as the discussion in later sections of this study shows.

Nevertheless, the role of substitute products for an industry should be addressed. According to Porter (1980: 23-24), the identification of substitute products for a certain industry is a matter of searching for other products that can perform the same function. In the case of videoconferencing versus air travel, this function is the interactive face-to-face communication between two or more persons. Porter sets forth that the position vis-à-vis substitute products may well be a matter of collective industry response. For example, heavy and sustained advertising by all industry participants might improve the industry's collective position. To what extent the airline industry may effectively respond to any negative impacts of enhanced teleconferencing systems in terms of product quality and profile, as well as marketing activities is subject of the discussion in section 5.

In general, substitute products are most significant for an industry if either (1) they are subject to trends improving their price-performance trade-off with the industry's product, or (2) they are produced by industries enjoying high profit margins (Porter 1980: 24). In case of videoconferencing, the first fact applies, primarily pushed through increased competition in the telecommunications industry leading to declining prices and improved performance.

A discussion and analysis of such aspects are therefore essential with respect to the decision of industry participants whether to try to head off a substitute or to develop a strategy containing the substitute as an inevitable component. When focusing on the issue of videoconferencing versus business air travel, the attempt to take advantage of the telecommunications trends and, consequently, the increasing integration of enhanced telecommunications into the airlines' product profile seems to be more promising than the attempt to outcompete videoconferencing across the board. Due to this technology's continuous, significant improvement in price-performance relative to air travel, trying to compete is likely to fail.

Porter's suggestion (1980: 32) to look beyond the ranks of one's competitors today to those that may arise tomorrow -- or that already are existent today but not recognized yet -- and to analyze competition well beyond existing rivals should be heeded by the airline industry. The current serious problems in terms of profitability, productivity, and competitiveness may cause airlines to overlook latent sources of competition that may someday impact the industry's development and profit margins in an even more significant manner.

2.3 Trends in Demand

Most historical data series of air travel demand do not distinguish between the two basic categories of air travelers, pleasure and business travelers. Passenger enplanement and revenue passenger miles (RPM) are usually given as total numbers for certain regional markets. Figures of first, business and economy class sales -- if available -- cannot provide the information about the purpose of trips. As already discussed before, an increasing portion of business travelers use coach class fares, with an apparent tendency toward taking more advantage of restricted, discounted tickets. Therefore, business travel shares are estimated through travel surveys, which, however, may have considerable bias as the succeeding discussion shows.

Focusing on the U.S. market (domestic and international), this section discusses past and present trends in air travel demand and subsequently the change in the relative portion of business air travel.

2.3.1 Air Travel Demand Development

The development of global air travel demand shows significant regional differences. According to the International Air Transport Association (IATA), worldwide RPMs were up 6% for the first nine months of 1993 (Dornheim March 14, 1994: 72). However, the growth of U.S. air travel was flat for 1993. System-wide RPMs increased by 1.3% (enplanements: 0.4%), while U.S. domestic air travel grew even slower at a rate of 0.1% in RPMs (enplanements: -0.1%; FAA 1994: III-5). These flat growth rates of U.S. air travel compare with double-digit rates in North-East and South-East Asia -- especially China with an annual growth in RPMs of more than 15%, the South-West Pacific, and between Western and Eastern Europe.

After years of high traffic growth in the early and mid 1980s, the U.S. market -- to some extent also the Western European market -- shows signs of being an increasingly saturated market. Particularly domestic business travel is widely assessed as having matured to a point where growth will now slow.

According to the Federal Aviation Administration (FAA) (FAA 1994: IX-12), in the past six years, the U.S. air travel market has grown with an average rate of only 1.1% per year; even though several "fare wars" in the domestic market have stimulated demand, particularly in the summer of 1992. Additionally, there is an inflation in the measured RPMs since it has to be understood that the RPM statistics

for U.S. air travel also contain the free miles flown on frequent flier awards, that there are increased flight distances in certain markets due to the increasing use of connecting flights through the airlines' hubs, that there are mileages waived by travelers when fares for connecting flights beyond the intended destination are cheaper than the regular fare for a direct flight, and that travelers often buy two roundtrip tickets associated with a Saturday night stay restriction since it is cheaper to throw away the return coupons than to buy a single ticket. All these factors contribute to a considerable inflation of RPM data and associated growth rates. It can, therefore, be assumed that the "real" growth of U.S. air travel in the recent past has actually been lower.

On the other hand, one has to be careful in the interpretation of last year's U.S. domestic growth rates (RPMs: +0.1%; enplanements: -0.1%; FAA 1994: III-5). These figures are largely a result of the return to more "normal" fare structures, compared to the deeply discounted promotional fares in 1992. Summer traffic (June through September) was up to 11.8% in 1992, while traffic declined by 0.6% during the remainder of the year (FAA 1994: I-5). For this reason, the summer 1992 market development masks the true underlying trends in 1993 and understates last year's "real" growth. It should be considered that during the first eight months of FAA's fiscal year 1993 (October 92 through May 93) the rate of growth of domestic traffic was 4.1% (FAA 1994: III-5).

International traffic of U.S. carriers increased in 1993 at significantly higher levels than domestic travel: 4.6% in RPMs, and 5.6% in passenger enplanements. This increase came on top of much higher growth levels in the previous year, which represented a clear rebound from heavily depressed levels of the Gulf War year 1991. This growth rate, however, contains significantly divergent regional trends. While Latin American travel increased by 21.4% in 1993, North Atlantic travel grew by 5.8%, and Transpacific travel even declined last year by 2.2% (FAA 1994: I-4).

In order to obtain information about trends in the absolute demand for business air travel of U.S. commercial air carriers, regionals and commuters, historical survey data from the Air Transport Association of America (ATA), which estimate the percentage of business travelers of total U.S. air travel (ATA 1994: III-28), have to be applied to historical enplanement or RPM data series for total U.S. air travel from the FAA (1994: IX-12; Apogee 1994: 3-5). Doing so (see Figure 2.3.1-1 for estimated enplanements of business travelers) reveals that most of the historical

growth in total enplanements of U.S. airlines (domestic and international) is attributable to the growth of pleasure travel. While the latter category grew at an average annual rate of 7% from 115.4 million enplanements in 1977 to 317.3 million in 1992, business passenger enplanements increased at a considerably lower annual rate of 2.7% from 125 million enplanements in 1977 to 186.3 million in 1992.

Figure 2.3.1-1 also illustrates that with respect to the non-discretionary travel this period can be divided into two phases: between 1977 and 1990, business travel grew in average by 5.1% per year; on the other hand, it declined in the period between 1990 and 1992 by 13% annually, experiencing more than half of this drop in 1992.

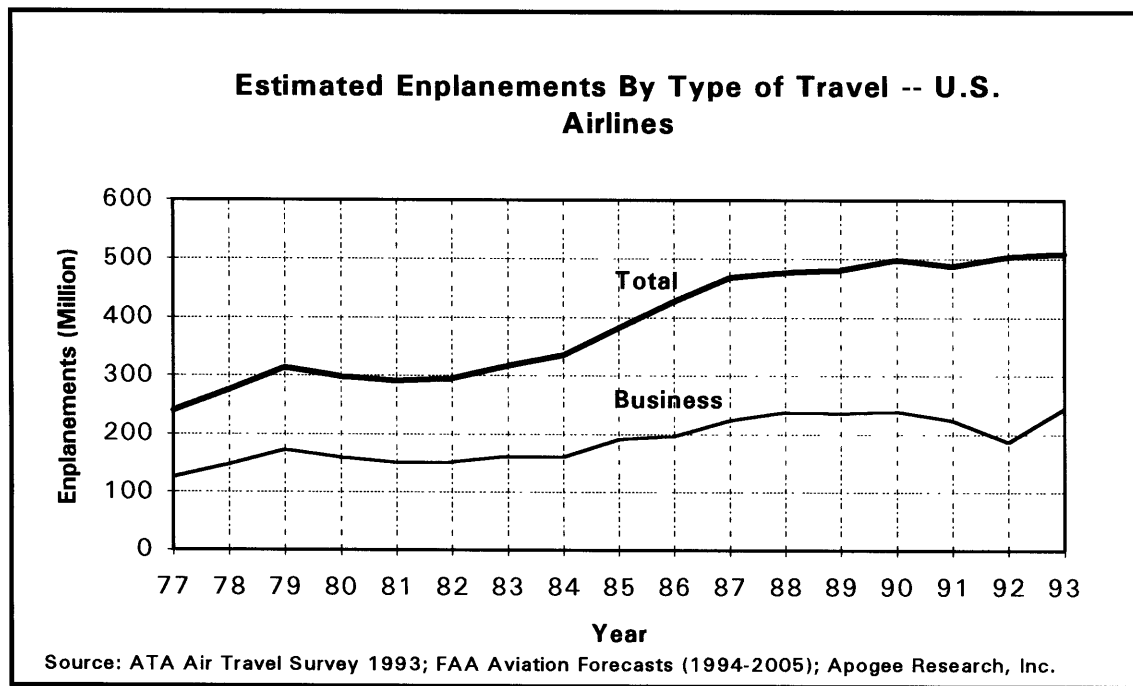


Figure 2.3.1-1: Estimated Enplanements By Type of Travel -- U.S. Airlines (1977-1993)

Integrating the 1993 data into this analysis has to be done carefully since the ATA has changed the time of the year for conducting its annual "Air Travel Survey". Until 1992, this survey was performed just after the summer pleasure travel season, but for collecting the 1993 data, the ATA conducted its telephone interviews of a random sample of 3,018 American individuals in February 1994. Although the ATA claims to have demographically balanced its survey sample, both cases suffer from potential sampling bias. An air travel survey just at the end of the summer peak travel season may over-represent pleasure travel, whereas February is

normally one of the flattest months of pleasure travel. Therefore, the 1993 survey may overstate the actual average annual share of business travelers. Nevertheless, the recovery of the U.S. economy has most probably contributed to a rebound of business air travel, even if the actual growth cannot be accurately interpreted from the data provided by the most recent ATA survey.

More reliable and detailed data are continuously collected by D.K. Shifflet and Associates, Ltd., in monthly intervals over the course of a full year through a mail panel comprising about 25,000 American individuals. This source, collecting data about purposes of business air travel in a rather detailed form, has already been referred to in section 2.1.2. However, these data are only available for a period since 1990 and can, therefore, not be used for long-term data time series. They provide, on the other hand, a more detailed understanding of the development in recent years.

Regardless of survey bias and the evident recovery of business air travel in 1993, it can be seen that overall U.S. business air travel -- domestically and internationally -- has shown a rather flat growth in the last several years, which industry analysts have attributed to Gulf War, recession, and higher price sensitivity of business air travelers. The role of modern telecommunications is only rarely proposed as an explanation (FAA 1994: III-19/-20).

2.3.2 Share of Business Air Travel

After discussing absolute trends in air travel demand, this section focuses on the development of the relative importance of the business travel share, again primarily with respect to the U.S. market (domestic and international).

Problems associated with data about the relative composition of air travel have already been discussed above. Besides the potential sampling bias due to the time of survey, sample size, and demographical sample composition, differences in published data about relative shares of travel types can also derive from different definitions, measures, and survey techniques.

Globally -- especially in international air traffic but also in domestic markets as the U.S. -- a decreasing relative share of business travelers is apparent. This fall is primarily due to the steady rise in personal incomes and the decline in real cost of air travel, attracting more pleasure travelers relative to business travelers.

According to Airbus Industrie (1993: 12), the portion of air travelers departing from U.S. airports for mainly business purposes is about 25%, compared to numbers in Europe and South-East Asia of almost twice as much, 47% and 51%, respectively. Also interesting is the distribution of air travelers among different fare classes. In North America, only about one of eight travelers (domestic and international) flies first or business class, whereas on flights departing from European and East-Asian airports around one third and one fourth of passengers, respectively, purchase such fares.

According to IATA (Wineberg 1992: 2), in 1990, business class travelers comprised only 13.8% of the international traffic but generated 26.2% of the revenue. This relationship indicates clearly that any replacement of business travelers -- particularly of business class travelers -- has a more than proportional impact on revenues. A fact that, with respect to the small profit margins of this industry, needs to be addressed for further consideration of substitute modes for business air travel.

As stated in the introduction of the thesis, the analysis of the relationship between videoconferencing and air travel is focused on the U.S. market. Therefore, trends in the relative proportion of U.S. business air travel and its composition should be the focal point of this discussion. The main sources for such data, the ATA and Shifflet and Associates, Ltd., have already been cited. Frequency, time of survey, sample characteristics, and associated sampling bias -- especially with respect to the ATA data, the only accessible source for long-term historical data series of demand composition -- have been discussed in section 2.3.1.

When comparing ATA figures with data obtained by Shifflet and Associates, one has to consider the time of the ATA survey: until 1992, it was just after the summer peak season. Figure 2.3.2-1 shows that between 1990 (first year of Shifflet survey) and 1992 the percentages of business travel determined by Shifflet are always higher than those obtained by ATA. Nevertheless, the persisting decline of the relative share of business travel until 1992 is evident in both data series. While, according to ATA, business travel declined from 55% of total U.S. air travel in 1979 and still 50% in 1988 to only 37% in 1992 (ATA 1994: III-28), the data obtained by Shifflet indicate a decline from 51.8% business air travel in 1990 to 42.1% in 1992 (Apogee 1994: Appendix B). However, in both cases, the data for 1993 (in case of Shifflet only the first seven months of 1993) show a rebound of business air travel: 48% according to ATA, and 44.3% according to Shifflet.

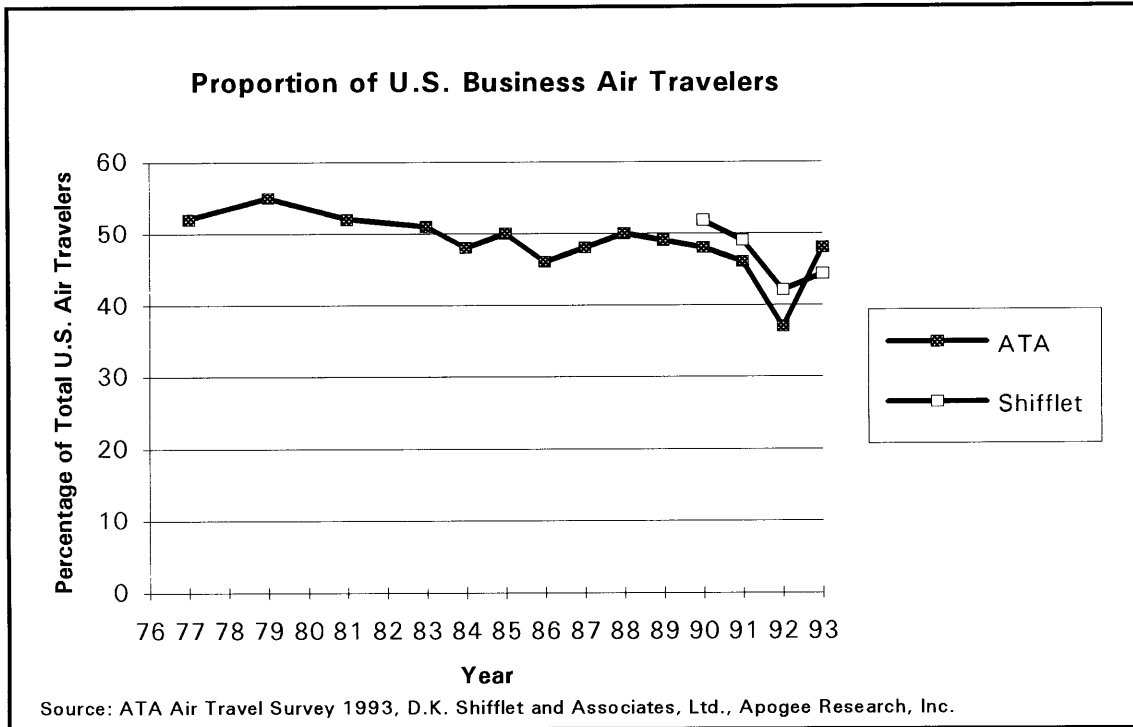


Figure 2.3.2-1: Proportion of U.S. Business Air Travelers

With the changed time of the ATA survey, the comparability of the 1993 data to previous years is limited. Also in case of the Shifflet data, it has to be considered that usually the relative importance of business travel in the first half of a year is higher than in the remainder of a year. When interpreting both data series, remember that the 1992 data are severely masked by the summer "fare wars" in several pleasure markets. However, independent of the accuracy of the numbers obtained in both surveys, it would seem that 1993 has seen an increase of the business travel share, not only due to the recovery of the business segment in absolute terms but also due to the return to more "normal" pricing in most of the pleasure markets. This positive trend in the business travel segment is also supported by the survey result (ATA 1994: III-30) where more respondents indicated a growth in their frequency of business travel (37%) than those that had experienced a decline (29%).

In section 2.1.2, the composition of U.S. business air travel by trip purpose has already been subject of a more detailed discussion. Although the survey data of D.K. Shifflet and Associates only cover the period from 1990 onwards, some short-term trends in business travel subcategories are evident (see Figure 2.3.2-2).

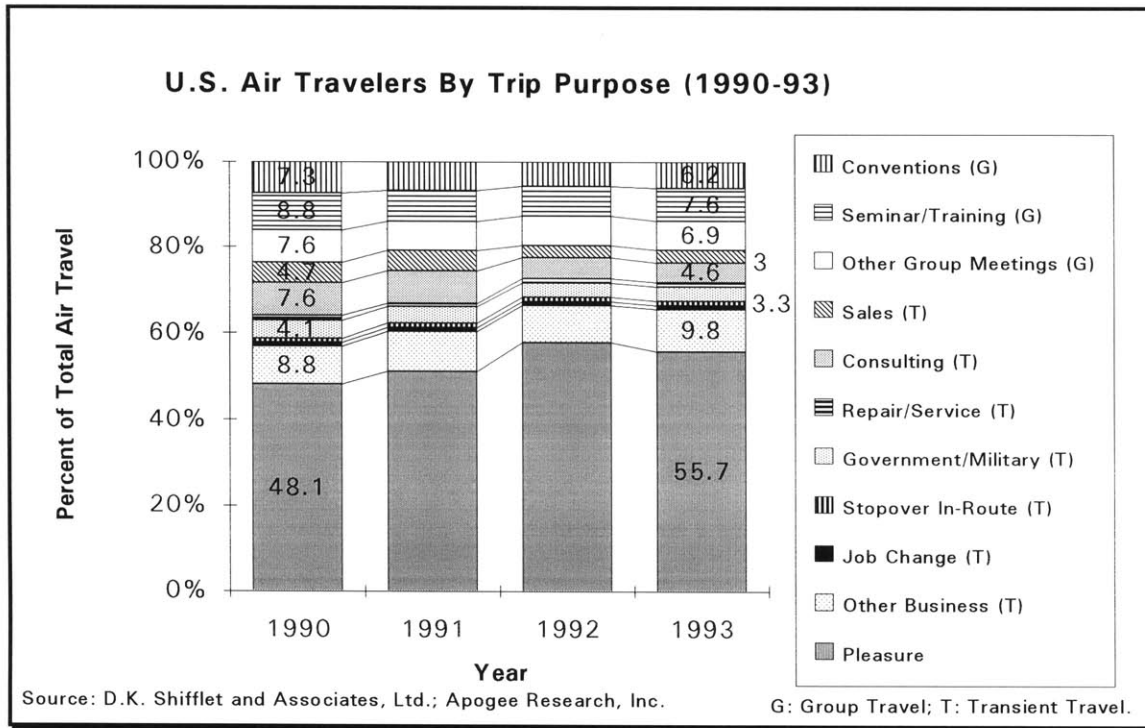


Figure 2.3.2-2: U.S. Air Travelers By Trip Purpose (1990-93)

The majority of decline of the business segment between 1990 and 1992 -- from 51.8% to 42.1%, has been caused by the decline in transient travel (see definition in 2.1.2), which decreased from 27.2% of total U.S. air travel in 1991 to 21.7% in 1992 (Apogee 1994: Appendix B). The relative portion of transient travel of total business travel declined in the same time from 55.5% to 51.5%. Particularly consulting, which dropped from 7.5% of total air travel (or 15.3% of business travel) in 1991 to 4.8% (10.3%) in 1992, contributed to this decline of the transient travel segment. Also trips related to sales activities have significantly declined from 4.8% of total traffic (or 9.7% of business travel) in 1991 to 2.9% (6.9%) in 1992.

On the other hand, group related meetings maintained a rather steady proportion of total air travel between 1991 and 1992. However, this segment also shows an evident drop in relative share of total air travel from 1990 (23.7%) to 1992 (19.6%). The decline of the portion of this travel category is largely due to the decline in conventions as trip purpose (from 7.3% of total travel in 1990 to 5.6% in 1992).

Although, according to Shifflet's data, the share of business travel has increased in the first seven months of 1993 compared to the whole year of 1992, a closer

look at monthly data indicates that the business travel portion has declined in four of the seven months in 1993. Transient travel has continued its fall, indicated by the decline of the relative share of this category's travel in five of seven months, including the normally strongest month of January. In this category, consulting maintained its negative growth trend while sales activities showed a slight recovery.

Analyzing these observations leads to the conclusion that the decline of transient business travel must be more related to economic factors and circumstances rather than to the impact of modern telecommunications, e.g., videoconferencing. Consulting and sales operations, the main contributors to the drop in the relative share of transient travel, are currently only minor applications of video- and teleconferencing in general. Constrained interoperability with client, customer and supplier systems, as well as an apparent preference of in-person meetings for such business purposes do not support a theory seeing a relationship between the current trends in transient travel and videoconferencing.

2.4 Business Travel Costs and Policies

Business travel costs comprise various cost components from which air fares -- if the trip involves air traveling -- represent the largest portion. However, discussing the costs of business travel and, later in the thesis, comparing those to the costs of videoconferencing must not be limited to air travel cost. On average, lodging, meals, car rentals, personal car costs, other ground transportation costs, entertainment, and miscellaneous account for more than half of total business travel expenditures. Therefore, the subsequent discussion also addresses developments in these business travel cost categories.

The price competitiveness of business air travel relative to substitute products such as modern telecommunications is -- due to the composition of total travel expenses -- by far not solely dependent on trends in air fares. Even if airlines may be able to further reduce their real fare levels, that does not automatically imply an overall improvement of the price performance of business travel since price trends in lodging, meals, car rentals, or other cost categories do not have to reflect similar tendencies. This shows that the collective response of participants of the travel industry to substitute products is definitely not limited to airlines but also has to include the other groups of the travel industry concerned with the needs of business travelers.

When analyzing developments in real business air fares, the problem arises which parameters should be taken as indicators. It is not sufficient to look at first or business class fares. Assuming that passengers in first and business class are primarily flying for business purposes, estimates provided by Airbus regarding travel motivation and fare class chosen by passengers (see section 2.3.2) would imply that today in the U.S. (including international flights) one out of two business travelers flies first or business class. In Europe, on the other hand, about two out of three business travelers fly these classes (Airbus 1993: 12). Also IATA sees a continued tendency toward more economy and discounted fares among business travelers, although significant differences with respect to region and length of haul have to be considered. For example, only about 60% of the respondents (frequent business travelers) of IATA's most recent corporate travel survey reported to fly first or business class on their business trips.

However, also examining overall average yields for the airlines does not provide a reliable picture of trends underlying business air travel expenses since pleasure fares, changes in the relative portion of travel types, trading down of classes and fares chosen by business travelers, and developments in capacities provided and associated load factors heavily mask the actual developments in average business air fares. Nevertheless, those airlines that track trends in average revenue per business traveler -- if done, not accessible for this research -- do recognize a continuous downward drift due to the increased look for economy class and discount tickets.

The discussion in the following section does not consider costs of unproductive time associated with business traveling. According to Khan (1987: 16), studies and surveys have shown that most managers spend up to 8% of their time in travel to meetings. Also, up to 50% of a manager's time are, on average, accounted for by scheduled meetings. These costs become relevant later in the thesis when the relationship between videoconferencing and business travel costs is discussed in detail.

2.4.1 Trends in Business Travel Costs

2.4.1.1 Past and Present Trends

According to estimates by American Express Travel Related Services Co. (Ehrenfeld April 93: 35-44), in 1993, U.S. corporations spent more than \$130 billion on travel and entertainment, a \$5 billion (4%) increase from 1992. Air travel

made up 43% of these total expenses. This development could be observed in spite of corporate travel budget cuts and enhanced telecommunications and was, according to American Express, mainly attributable to the increase of international trade and travel.

Nevertheless, despite economic recovery, companies continue to look closer at the necessity of individual business trips and monitor the number of employees routinely traveling on business (Runzheimer 1992: 2). On the other hand, travel vendors have felt the pressure for corporate cost control in their negotiations for new contracts with corporations. Previously negotiated fares for corporate air travel packages remained unchanged in most cases, more firms are receiving deeper hotel discounts, and car rental firms have found little relief in pricing (Runzheimer 1992: 4).

The percentage for air fares of total business travel costs determined by American Express (43%) is also confirmed by Runzheimer's regular "Survey and Analysis of Business Travel Policies and Costs". The latest data available for this thesis (Runzheimer 1992: 2) show air fares at 46% of total business expenditures (see Table 2.4.1.1-1). Lodging, the second largest cost component, accounts for almost one quarter of cost, while meals and car rentals together contribute another 20%. The figures for the period between 1987 and 1991 also indicate that the distribution of major travel expenses has remained fairly constant. No cost component has notably changed relative to the others.

Runzheimer's survey and analysis also reveal a significant shift toward the use of non-refundable, discounted tickets by businesses. The portion of companies encouraging the use of such fares has grown from 34% in 1990 to 49% in 1992 (Runzheimer 1992: 3). Generally, companies seem to be more lenient with international travel than domestic travel expenditures. Although flying in first class has declined, more corporations permit the use of business class. Also economy class has seen a slight increase among U.S. business travelers (Runzheimer 1992: 6).

Nevertheless, Runzheimer (1992: 5) comes to the interesting result that in spite of this tendency and the on-going price competition in deeply discounted, promotional fare categories, average domestic ticket costs moved up drastically by 21.6% from \$431 in 1989 to \$524 in 1991. Average international fares, on the other hand, were up only about 4% between 1989 (\$1,715) and 1991 (\$1,789).

The average rates for lodging maintained a constant level of \$80 per night, while average daily car rentals even declined slightly from \$38 (1989) to \$36 (1991).

Table 2.4.1.1-1: Proportions of Travel Expenditures in Each Expense Categories

Category	1987	1989	1991
<i>Airfare</i>	44%	46%	46%
<i>Lodging</i>	22%	21%	23%
<i>Meals</i>	12%	11%	11%
<i>Car Rentals</i>	9%	9%	8%
<i>Entertainment</i>	4%	5%	4%
<i>Miscellaneous</i>	3%	3%	3%
<i>Personal Car Cost</i>	3%	3%	3%
<i>Other Ground Transport</i>	3%	3%	2%

Source: Runzheimer International (1992)

Although, as stated before, overall yield trends cannot be taken as sole indicator for the development in business air travel expenses, the last recent trends should be briefly discussed subsequently.

U.S. domestic real air fares declined approximately at an annual level of 3.3% from 1982 through 1992 (FAA 1994: III-25). In 1993, real yields grew by 3%, compared to a decline of 6.9% in 1992 (FAA 1994: III-3/-5). With respect to the normalization of fare structures after the volatile price competition in summer 1992, this development was expected. While the average yield remained almost constant - compared to 1992 levels -- in the first seven months of FAA's fiscal year (October 92 to April 93), average fares were up some 20% in the summer period of July and August. Since business travel is usually flat in this time and the average yield changes are primarily due to changes in the non-restricted, discounted fares, the latter trend should not have impacted average business travel fares notably.

Real international yields decreased an average of 2% per year between 1982 and 1992. In 1993, a decline of 3.6% was reported (FAA 1994: III-27, IX-10).

2.4.1.2 Future Perspectives

Forecasts for future developments in the four major corporate travel categories - air fares, lodging, meals, and car rentals -- are rare. On a short-term basis, such projections are made by travel management consulting firms as Runzheimer International, Topaz Enterprises, or American Express Travel Related Services.

Current evaluations see air fares rising by 4.5% (Runzheimer; American Salesman January 1993: 18-19) to 10% annually (American Express; Ehrenfeld April 1993: 35-44). Meals and car rentals are evaluated to increase at about the level of inflation of 3% per year, while a continued excess of hotel rooms is expected to keep prices flat (-0.5% per year; Runzheimer; American Salesman January 1993: 18-19).

Focusing the discussion on projections of future air yield trends shows that most evaluations and forecasts expect fairly flat yields for the U.S. market. Boeing (1992: 2.8, 2.9, 2.15) estimates an average annual decline in world airline yields of 0.3% until the year 2000, whereas U.S. airline yields are forecast to remain flat -- growth between 0% to 0.3% per year. Airbus (1993: 10, 60, 61) widely confirms these projections and expects real fares of world airlines to continue to decline in the order of 0.5% annually through the end of this decade, sustained by liberalization, increased competition, and cost-cutting measures within the industry. For North America, average annual yield decreases between 0% and 0.3% are projected.

Also the FAA (1994: I-7, III-25) forecasts rather flat yields for the U.S. market over the next 12 years. Real domestic passenger yields are estimated to decline slowly at a rate of 0.5% per year as competitive forces and current restructuring efforts continue to exert downward on fare levels. On a system basis -- including international markets -- real yield of U.S. airlines is expected to decrease an average of 0.4% in each year through 2005.

In the response to the survey conducted among international airlines for the purpose of this thesis, the tendency is apparent that European airlines expect rather flat business fares in their domestic markets, while increased competition causes them to project declining fares in their international markets. Heterogeneous evaluations are received from U.S. airlines. In international markets, business fares are assessed to remain flat and rather increase, whereas, to the same extent, contradictory estimates -- "increasing" and "decreasing" -- are given with respect to future fare developments in the U.S. domestic market.

2.4.2 Corporate Travel Budgets and Policies

Most studies and surveys trying to identify trends in corporate travel policies and budgets reveal that budgets continue to be under pressure. Although travel remains vital to companies in conducting their businesses, keeping travel expenses

in check is high on executives' list. Runzheimer (1992: 2) comes to the conclusion that travel policies have clearly tightened in content and compliance. In order to get a grip on travel costs, companies that still do not have formal travel policies are increasingly articulating them, and installing mechanisms to ensure compliance (Ehrenfeld April 1993: 35-44).

IATA Survey

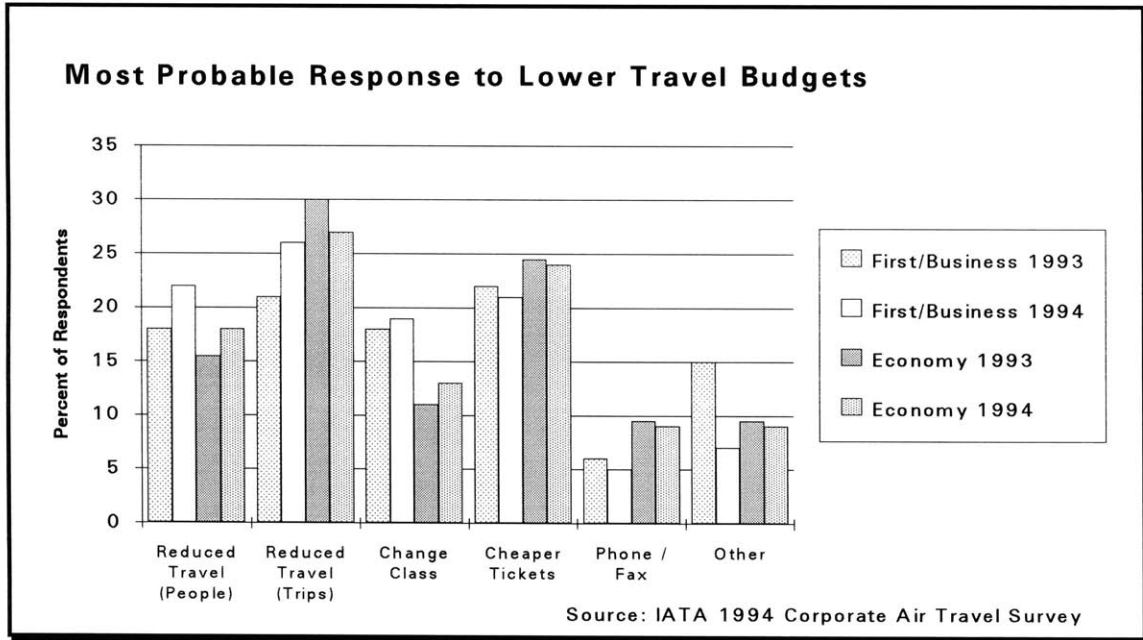


Figure 2.4.2-1: Most Probable Response to Lower Travel Budgets

Travel budget trends are also an elementary component of IATA's annual "Corporate Air Travel Survey" (IATA April 19,1994; Business Travel News May 16, 1994: 20). For the third consecutive year, more corporations report a decrease in travel budget than an increase. The ratio is two to one. However, more than half the respondents reported no fluctuations in their firms' travel budgets in 1993. On the other hand, for the volume of air travel generated, the balance is even: 22% reported an increase of their companies' air travel, while 21% experienced a decline. This shows that companies are clearly taking advantage of better deals, meaning lower fare classes and/or discounted tickets in order to maintain travel levels in spite of budget cuts.

Interesting are also differences in these assessments with respect to company sizes. While more than one third of survey participants working for companies with more than 1,000 employees reported an overall decrease in air travel budgets, only

20% of those working for companies with less than 25 employees experienced budget cuts.

Both business travelers flying economy class and those in first or business class reported their companies' initial and most probable response to budget cuts would be reducing the number of trips taken annually (see Figure 2.4.2-1). First and business class travelers, furthermore, stated the reduction of the number of people traveling as the second most probable response, whereas economy class passengers named the purchase of cheaper tickets as next step. Increased use of telecommunications as response to tighter constraints on travel budgets is also given as alternative by 9% of economy class passengers and 5% of first/business class travelers. However, with respect to the definition "telephone/fax" chosen in the survey, it is not clear whether videoconferencing was also included in this assessment, or whether it would rather belong into the category "other".

The IATA survey also reveals significant regional differences in company air travel budgets. North American companies appear more likely to cut both budgets and travel than their counterparts in Europe and Asia/Pacific.

Nevertheless, with respect to future travel budget and travel volume trends, the surveyed business travelers provided more optimistic evaluations. The number of survey respondents expecting increases in both categories outweighs those anticipating a continuation of budget and travel decreases.

Survey of Videoconferencing Users

Trends in travel budgets have also been an aspect in the videoconferencing survey designed for the purpose of this study (see Appendix 1 and 2; questions 7a - 7c in corporate questionnaire, and 4h - 4j in user questionnaire).

More than half of the respondents to the user questionnaire reported an increase of their personal business travel expenses in the last 12 months (47%: slightly increase; 7%: significantly) while only one out of four has experienced a decline in expenses (20%: slightly; 7% significantly). The residual 20% stated no real change in their business travel budget. Therefore, contrary to the results of the IATA survey, the number of respondents reporting an increase in travel expenses outweighs those having experienced the opposite with a ratio of two to one. Nevertheless, contrary to the IATA survey of more than 1,000 frequent inter-

national business travelers, the results above only base on a weak sample size of 18 videoconferencing users, most of them less frequent fliers.

In the corporate questionnaire, the development in overall corporate travel budgets in recent years (real terms) has been asked. As opposed to the user questionnaire, the budget trends surveyed in this questionnaire are not limited to the recent 12 months. "Recent years" are in most cases equivalent to the time since companies have been using videoconferencing (see section 4.5.3). The results do not confirm the answers of individual users. More than three quarters of respondents reported a decline of their overall company travel budget (47% slightly; 29%: significantly). Only 13% have experienced an increase. The same number reported no real change in their corporate travel budgets in the recent past.

Reasons for the divergence of both survey results can be seen in the different time horizon in the question formulation. The user response might be primarily impacted by the notable economy recovery in the last 12 months whereas the corporate observations include the recessionary trends of the early 1990s. In addition, subjectivity of the videoconferencing managers in their interest to emphasize the role and impact of videoconferencing might bias their assessment. The individual users of videoconferencing, on the other hand, probably do not have the incentive to support with their answers this technology in disfavor of travel.

Also with respect to the assessment of future travel budget trends, the possible bias in the evaluations of the videoconferencing managers has to be considered. This time, in both questionnaires, participants were faced with basically the same question as regards the expected future development of corporate and personal business travel budget, respectively. While only 38% of the users expect cuts in their budgets (25%: slightly; 13%: significantly), the figure is more than 75% in the corporate survey. And, 44% of the users expect no real change in their personal business budget whereas even 18% anticipate an increase. In the corporate survey, 18% expect no real change and 6% await an increase in the company's travel budget. The figures of both questionnaires do not support the optimistic trend determined by the IATA. Compared with the assessments given with respect to the past development, travel budgets are expected to become under increasing pressure.

Videoconferencing managers and individual videoconferencing users widely agree about the most probable response to decreased travel budgets: Video-

conferencing is claimed to be the prime alternative (62% in corporate survey, and 57% in user survey). Less face-to-face meetings and, therefore, less travel are assessed as the next probable response (19% in corporate survey; 36% in user survey). Only 14% of videoconferencing managers and 7% of users see cheaper tickets as most probable alternative.

These numbers do not confirm the IATA survey results (see Figure 2.4.2-1), where the significance of telecommunications as probable response to travel budget cuts is assessed to be rather low (5-9%). The limited representativeness of the survey sample in this thesis, as well as the fact that our survey was focused on videoconferencing users, who show different acceptances and preferences with respect to videoconferencing than frequent business air travelers, who, on the other hand, may have personal preferences for traveling and no experience with videoconferencing, have to be considered as regards these deviations.

2.5 Current Forecasts

This section discusses existing forecasts of future developments in air travel demand with focus on business air travel. Although the primary interest of the thesis is in trends in U.S. air travel demand comprising domestic, as well as international traffic, global trends are also subject of the subsequent discussion and are compared to projections for the U.S. market.

2.5.1 Global Developments

Current forecasts by the three leading airframe manufacturers and IATA for global air travel growth through the year 2000 range from average annual rates of 5% in RPMs to 5.9% (Airbus 1993: 14; Boeing 1992: 2.28; Air Transport World April 93: 9; Phillips November 1, 1993: 26-27; Dornheim March 14, 1994: 72-74). Within this period, it is expected that annual growth rates show a declining tendency, decreasing from 6.3-6.6% until 1996/97 to 5-5.5% in the subsequent years through the end of the decade.

In this context, it has to be addressed that most recent trends in air travel demand have been interpreted in different ways and integrated into revisions of forecasts by the manufacturers. McDonnell Douglas has significantly lowered its 1993 long term forecast of annual global growth rates of 6.7% in RPMs to slightly more than 5% in the 1994 market projections due to the recognition of market maturation in some regions -- particularly in the U.S. market --, expected growth of

fuel prices and real yields, and increasing substitution of business travel through enhanced telecommunications (!) (Dornheim March 14, 1994: 72). Boeing, on the other hand, in the 1993 market forecast saw reasons for correcting its 1992 values slightly upward.

As regions of highest growth rates in the next 10 years and probably also beyond, all these market projections identify East-Asia, the Pacific region, and air travel to and from Eastern Europe. The average annual rates range from 8% to 10% in RPMs. However, also Transpacific traffic (North America-Asia/Pacific) is seen as a fast growing market (7.5% to 8.5% per year). These rates compare to clearly lower annual growth projections for the North Atlantic (about 5%) and particularly the U.S. market (4-5%). All sources agree that the latter market, especially U.S. domestic traffic, will experience the flattest growth through the next 10 to 15 years. The forecasts of the FAA (1994: III-35) confirm these evaluations for the U.S. market and can be placed at the lower bound of the projected growth interval of 4% to 5% in RPMs annually (FAA: system-wide 4.5%, domestic 3.7%). Nevertheless, as the subsequent section shows, also sources predicting even lower annual increases of U.S. air traffic can be found in the literature.

M.I.T. Survey of Aircraft Manufacturers and International Airlines

More disaggregated forecasts that distinguish between pleasure and business air travel and their divergent rates of growth can barely be found. In the questionnaire that has been submitted to airframe manufacturers and international airlines in Europe, North America, and East-Asia for the purpose of the thesis, current forecasts and expectations -- mainly qualitative -- for the growth of business air travel in the most important business markets worldwide for the next 10 years have been solicited.

This survey (see Figure 2.5.1-1) shows that the Eastern European market is evaluated as having the potential for the highest growth rates of business travel; 50% of respondents expect an average annual growth of business air travel in this region at a level of 4-6% in RPMs, while one third of respondents project rates even exceeding 10%. Most airlines and manufacturers also agree about strong growth in the Pacific and Intra-Asian business travel markets -- majority of estimates in the order of 4-6% in RPMs per year. The Common European business market is expected to grow an average of 2-4%, though even some evaluations are at higher levels. A more heterogeneous picture is obtained for the expected development of

business travel between Europe and the Asian-Pacific region. However, most respondents forecast growth rates of 1-4% per year.

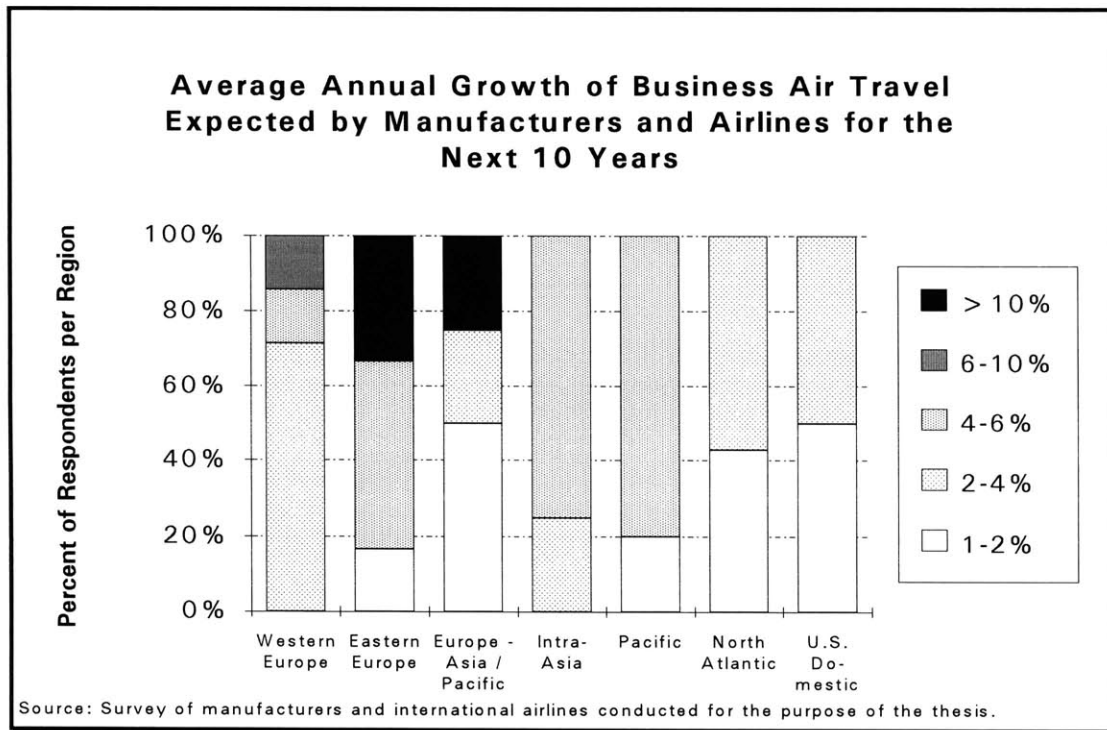


Figure 2.5.1-1: Average Annual Growth of Business Air Travel Expected by Manufacturers and Airlines (Next 10 Years)

As expected, the slowest growth is projected for the North Atlantic and particularly the U.S. domestic market. In average, the figures are around 2% per year for the latter business market and slightly higher for the North Atlantic.

Business Air Travel Share

According to evaluations of Airbus Industrie (Peter Jost, General Manager for Marketing Planning: phone conversation with author; Airbus 1993: 12; Wineberg 1992), the proportion of business travel of total global air travel will have declined by further 20% from today's level by the end of the decade, reaching a relative share of about 25%. Within Airbus' overall forecast period through 2011, the share of business travel is expected to decrease to some 20% of the total travel volume.

Capacity Growth

Finally, a brief summary of existing forecasts for capacity growth should be provided. The market for new jet airliners between today and the year 2010/11 is expected to be of a volume of approximately 12,000 aircraft (Boeing 1992: 3.4;

Airbus 1993: 75; Air Transport World April 1993: 9). Growth will cause 65% (McDonnell Douglas' estimate) to 75% (Boeing) of this market, and the residual portion is needed for replacement. While the initial focus of this growth (in units) will be on narrowbody aircraft for short- and medium-haul services, large widebody aircraft are expected to account for an increasing portion after the year 2000. Overall, these projected jet aircraft deliveries would represent a market of about \$800 billion until 2010/11, or an average annual market of around \$45 billion. North American airlines are forecast to receive 35-37% of these new aircraft.

2.5.2 U.S. Market

FAA Aviation Forecasts

The most common reference for forecasts of the development of the U.S. air travel market are the annual "FAA Aviation Forecasts". These market projections are based on analyses of various economic scenarios and regression models with different historical time frames (FAA 1994: III-20/21). The key parameters used are gross domestic product (GDP), consumer price index, and oil and gas deflator (FAA 1994: II-5).

The FAA also attempted to create a forecasting model splitting the market into business and personal travel (FAA 1994: III-20). However, this approach was rejected due to lack of sound data. As stated before, the only historical time series material available for such a purpose, the annual "ATA Air Travel Survey", is missing for some years and contains considerable sampling bias due to the survey timing (until 1992: end of summer season) and, therefore, to the high sensitivity to trends in the pleasure market (see also discussion in section 2.3).

As already said in section 2.5.1, the FAA (1994: III-35/-37) projects an average annual growth in U.S. system RPMs of 4.5% throughout the next 12 years. Domestic RPMs are forecast to increase by 3.7% annually and domestic enplanements by 3.5%. International RPMs of U.S. air carriers are expected to grow at an average of 6.3% per year and international enplanements by 6.5%. This rate contains regional variations, ranging from 5.9% and 6% in RPMs annually for the North Atlantic and Transpacific traffic, respectively, to 8.3% for Latin American traffic. These different growth rates of domestic and international traffic will apparently cause a shift in the relative distribution of total U.S. air travel. Domestic traffic is likely to decline from today's 72% to about 66% in 2005.

Econometric Approach by Apogee Research

Although the FAA, as discussed above, rejected a forecast model that divides the market into business and personal travel, this approach has been attempted by Apogee Research, Inc. (1994). In their study assessing the potential impact of modern telecommunications on air travel, prepared for the FAA (!), they developed different econometric models for business and pleasure travel demand. This required the use of the survey results for the split of total U.S. air travel in business and personal travel from the "ATA Air Travel Survey" -- available since 1977 -- and of FAA's historical data series of U.S. passenger enplanements (see also section 2.3.1).

In the econometric models for business travel, a strong correlation (square of coefficient of correlation, R^2 : 0.94 to 0.96) between the number of enplanements and the economic parameters GDP, corporate profits, employment, and sales, as well as the average yield is evident (Apogee 1994: 13-16). However, in order to receive a significant correlation, the 1992 data masked by the price competition in the pleasure market had to be excluded.

None of the models developed by Apogee is clearly superior to the others. On the basis of growth rates averaged from the assessed models, U.S. business enplanements (domestic and international) are forecast to grow between 2.3% and 3% annually through the year 2005. The average annual growth would be 2.4%. However, these data are based on the assumption that there is no increase in price sensitivity of business travelers. Apogee's regression analysis provides an average historical price elasticity of (-0.6). When the same economic models are estimated through 1992, the value for price sensitivity also changes. Adjusting the models for the underlying trend of increased price sensitivity of business travelers would imply a long-run average growth of only 2.1% annually.

Even regardless of the historical limits, survey timing and sensitivity to trends in the pleasure market, associated with the ATA survey data, the approach chosen by Apogee cannot be applied to future projections due to the change of time of ATA's "Air Travel Survey" and, therefore, the confounded relationship to data time series from 1977 through 1992.

After modeling pleasure traveler enplanements in a similar way as done for business passengers, the addition of both forecasts leads to an expected average growth of overall U.S. air travel of 3.1% annually through 2005 (Apogee 1994: 16-

19). This rate lags significantly behind the 1994 forecast of the FAA (1994: IX-12) that projects an average annual growth of 4% in total U.S. airline enplanements. Nevertheless, also other sources forecast growth rates significantly below the FAA figures. Aviation Systems Research Corp., for example, sees U.S. domestic annual growth rates in enplanements for the coming years at a level of only 2.8% (Velocci January 3, 1994: 36).

The growth rates for business travel of 2-2.5% per year determined in the Apogee approach after adjusting for increased price sensitivity are confirmed by both the evaluations of airlines and manufacturers received from the survey conducted for the purpose of the thesis (see earlier discussion and Figure 2.5.1-1) and projections by the U.S. Travel Data Center for the next years (Fisher October 25, 1993: 6).

3 VIDEOCONFERENCING

3.1 Videoconferencing -- A Form of Modern Teleconferencing

3.1.1 Teleconferencing Systems

Teleconferencing, defined in a simple and brief way, covers a full range of telecommunication media and services enabling individuals and groups in dispersed locations to hold a meeting and exchange information without having the need to travel to a single place.

In the following, three basic types of teleconferencing are distinguished: Audioconferencing (audio-teleconferencing), videoconferencing (video-teleconferencing), and computer conferencing (screen sharing, groupware).

Audioconferencing:

The most commonly used form of teleconferencing is the audioconference. Though it does not provide the feature of video images, its wider access, lower complexity, and, of course, lower cost make it an important business tool. A conference telephone is the simplest form of audioconferencing. Conferences can be held point-to-point or multipoint involving a larger number of participants.

Audioconferencing is highly suitable for meetings when the purpose is to exchange information or discuss issues. Also, presentations can be made whenever attendees are familiar with each other and the topics and when visual aids are not a necessary support. Typical uses involve general business meetings, industry or press briefings, and training. These applications are primarily for intra-company activities (Wakin March/April 1994: 26).

Audioconferencing is not appropriate when face-to-face contact is essential in a meeting, e.g., high-level and sensitive negotiations, motivational meetings, consensus building, and a series of inter-company activities where the in-person atmosphere is still fundamental (Wakin March/April 1994: 26). In the international area, cultural aspects and time-zone differences may limit a wider adoption.

A audioconference can be supplemented by the use of fax, interactive graphics, e.g., electronic whiteboards, or telewriting pads, as well as screen sharing (see later in this section).

Videoconferencing:

Videoconferencing, on the other hand, adds the face-to-face interaction to the conventional audio or electronic teleconferencing meeting. Simply said, videoconferencing is an upgrading of audio-teleconferencing and, therefore, can be used for much wider applications than the latter form. Characteristics, systems, technology, applications, as well as limits and benefits of videoconferencing are discussed in detail throughout the subsequent sections of the thesis.

Videoconferencing is appropriate for almost all kinds of business meetings where an in-person atmosphere is not imperative. In spite of the addition of the video component, it may still not be suitable for high-level negotiations and other forms of sensitive meetings. Limits in the acceptance for inter-company purposes, particularly customer contacts and services, and for international meetings with respect to cultural acceptance and time differences are still evident.

Primary business applications for videoconferencing can be found in the areas of research and development, engineering, project management, finance, and administration. Increased use is also apparent for product presentations, training, and interviews.

Videoconferencing is the prime teleconferencing system whose interrelationship to business air travel is evaluated in this thesis. However, videoconferencing cannot be seen as an isolated system. Modern video applications involve often the use of fax and other interactive graphical systems. The most sophisticated forms, electronic whiteboards or screen sharing, enable conference participants to view and manipulate synchronously the same document, graphics, or program code. Also simple flip-charts and other commonplace presentation graphics and tools, such as video clips, are often integrated in a videoconference.

Computerconferencing:

Computer conferencing, including applications named screen sharing and groupware, is used when a text-centered meeting is needed, rather than a meeting in need of voice and video transmissions. Collaborative computing enables attendees in multiple sites to work together on a document while remaining at their own computer stations (Wakin March/April 1994: 26).

Table 3.1.1-1: Comparative Overview of Teleconferencing Systems

	Audioconferencing	Videoconferencing	Computer conferencing (Screen Sharing; Groupware)
<i>Suited for</i>	<ul style="list-style-type: none"> ♦ Meetings when main purpose is to exchange information or discuss issues. ♦ To some extent, also for giving presentations not relying on visual aids. 	<ul style="list-style-type: none"> ♦ Basically for almost all kinds of today's business meetings where in-person experience is not essential. 	<ul style="list-style-type: none"> ♦ Text-centered meetings and documented decisions. ♦ Teamworking on technical papers, drawings, and programs. ♦ "Bridging" of time zones in international collaboration.
<i>Typical uses in corporations</i>	<ul style="list-style-type: none"> ♦ General business meetings, industry or press briefings, training programs, and partially also remote presentations, primarily intra-company. 	<ul style="list-style-type: none"> ♦ Meanwhile used for nearly all types of business meetings, particularly intra-company. ♦ Primary applications: research & development, engineering, project management, finance, and administration; increasingly used for product presentations, training, and interviews 	<ul style="list-style-type: none"> ♦ More technically oriented areas: research & development, engineering, design, or training. ♦ Also used for joint writing projects, and customer surveys.
<i>Not suited for</i>	<ul style="list-style-type: none"> ♦ All meetings in need of face-to-face contact or visual aids, primarily high-level and sensitive negotiations, motivational meetings, consensus building, or presentations relying on visual aids. ♦ Particular limits for inter-company and international applications (cultural, time-zone differences). 	<ul style="list-style-type: none"> ♦ All meetings relying on in-person atmosphere, especially high-level and sensitive negotiations, or particular customer contacts. ♦ Still evident limits for inter-company and international applications (cultural, time-zones). 	<ul style="list-style-type: none"> ♦ All forms of meetings and conferences in need of audio and face-to-face contact between attendees, especially if participants are not familiar with each other and without common work experience.
<i>Supplements</i>	<ul style="list-style-type: none"> ♦ Fax, interactive graphics (electronic whiteboards or telewriting pads), screen sharing. 	<ul style="list-style-type: none"> ♦ Fax, interactive graphics (electronic whiteboards or telewriting pads), screen sharing. 	<ul style="list-style-type: none"> ♦ Fax, audio- and videoconferencing.

Members of a "virtual" team connected by network or modem are able to view and manipulate the same page layout and graphics and can produce a documented decision that is instantaneously and completely communicated to all conference participants. Each conferee can point, circle components or words, or write a comment. All work appears on the screens of all participants, and different colors differentiate the individuals' actions (LaPlante September 13, 1993: 112).

Computer conferencing is most suitable in highly technical areas, such as research and development, engineering, design, and also for training purposes. In addition, joint writing projects and customer surveys are areas of usage. Screen sharing applications, as stated before, are also increasingly popular in combination with videoconferencing. Doing so, participants are not only able to share documents on their screens but also to view the partners' images. These video images can be generated on separate monitors or on the same one as text and graphics, e.g., desktop videoconferencing (see section 3.3).

Of course, computer conferencing is not suited for all forms of meetings needing audio and face-to-face contact between attendees. Furthermore, problems can arise if participants are not familiar with each other and without common work experience.

However, computer conferencing does not have to be a simultaneous ("on-line") interaction between people in dispersed locations. Asynchronous computer conferencing works on a delayed basis and provides not only "space-spanning" but also "time-bridging" (Svenning 1994). Such asynchronous applications are also described as groupware. By creating a topical electronic database, conferences and forums can run continuously 24 hours a day and people can attend whenever they want. The simplest form of groupware is electronic mail (e-mail). However, while conventional groupware enables multipoint meetings (many-to-many interactions), e-mail is generally limited to one-to-one or one-to-many communication (LaPlante September 13 1993: 112-117).

A comparative overview of the different forms of teleconferencing discussed above is provided in Table 3.1.1-1.

3.1.2 Introduction to Videoconferencing

Videoconferencing is widely regarded as the most enhanced and popular means of modern teleconferencing. Because it provides face-to-face contact and inter-

active information exchange -- usually the basic incentives for business travel, it is assessed as the telecommunication form having the greatest impact on this type of travel. Nevertheless, the discussion of the relationship between videoconferencing and business air travel in subsequent sections of this study also includes the other forms of teleconferencing, particularly with respect to increasingly integrated applications for business communications.

Generally, videoconferencing can be divided into (a) systems providing two-way video and two-way audio, point-to-point transmissions, (b) systems enabling one-way video and two-way audio, multipoint interaction, and (c) systems allowing multipoint transmissions of both audio and video. The systems can, furthermore, be classified into the three basic groups: (1) boardroom, (2) portable ("roll-about"), and (3) desktop systems. All these categorizations and the specific systems' characteristics are subject of a more detailed discussion in section 3.3.

As basic equipment, a videoconference needs at each site a camera, a microphone, and a monitor. In a typical videoconferencing meeting, participants in each site gather around a monitor. A camera next to, or on top of, the monitor is automatically (voice sensor, voice activation) or manually guided to individual participants or focused on the entire group. A codec (coder/decoder), usually underneath the monitor, digitizes and compresses the signal from the camera and sends it over a data network -- via microwave, coaxial cable, fiber optics, cable television system, or satellites. In a two-site meeting, each site sees the other on their respective monitors. In a multi-site conference, at least the site at which a person is talking is seen by all participants. Also, the showing of questioner and answerer is often applied.

3.2 Evolution of Videoconferencing

This section discusses the historical evolution of videoconferencing characterized by acceptance problems throughout the last three decades, the main factors responsible for the final breakthrough of the technology, and today's perspectives of videoconferencing. It is shown that videoconferencing has developed from an extravagant luxury available only to some governmental organizations and the largest corporations to an affordable and efficient -- almost commonplace -- communication tool accessible to businesses of all shapes and sizes (Johnson May 21, 1993: 67-72).

3.2.1 Early Adopters

Videoconferencing was first introduced 30 years ago at the 1964-65 New York World's Fair. With early videophone concepts, it was attempted to penetrate the telecommunications market. However, the technology experienced a clear false start and failed to become commercially viable to any significant degree.

Videoconferencing industry analysts believe that the primary reasons for the slow market penetration and adoption of videoconferencing have been the high transmission costs (1970: about \$2,000/hour in average for a domestic conference), the cost of early codecs (1980: around \$230,000; regarding function of codecs see section 3.3), the cost of videoconferencing rooms (1981: between \$0.5 and \$1 million), the lack of standards for compressed video and, therefore, of interoperability between systems, and the lack of local access circuits (local telephone network limitations) associated with less developed compression techniques available in the past (Gold 1989: 3-4).

While audioconferencing gained popularity in the early 1980s, the real breakthrough of videoconferencing did not occur before the end of the last decade. Particularly for small and mid-size companies, audioconferencing was the only kind of teleconferencing used until the 1990s (Wakin March/April 1994: 25-26).

Government organizations and agencies, particularly in the defense sector and the NASA, were the first heavy adopters of teleconferencing and early forms of videoconferencing, before during the 1980s, videoconferencing slowly penetrated the business world. Large corporations were the trendsetters in this technology.

According to a Runzheimer survey conducted in 1983 (Tealeb, Orton 1985: 14-15), 50% of U.S. firms with annual sales revenue exceeding \$1 billion were using some form of videoconferencing. Smaller companies with sales under \$1 million used almost exclusively audioconferencing or audiographics. Only 5% of these firms had already adopted to videoconferencing.

More than one third of the companies using any form of teleconferencing ten years ago evaluated savings in travel time as the main benefit. Another 7% saw savings in travel expenses as biggest advantage of this technology (Runzheimer; Tealeb, Orton 1985: 15). This shows that for early adopters of teleconferencing, travel replacement savings were the primary drivers. On the contrary, most of today's customers are taking a more strategic view of the role of videoconferencing

to improve their total business (Gold 1989: 9; see later discussion, particularly in sections 3.6, 3.7, and 3.8).

Nevertheless, companies newly adopting to videoconferencing today, often set business travel cost and time savings as a prime factor in their investment justification. These aspects are the subject of a more extensive discussion in several subsequent sections as well (see especially section 4.3).

3.2.2 Breakthrough

After about two decades of failing to become commercially viable, videoconferencing reached its real breakthrough in the telecommunications market in the late 1980s and early 1990s. When looking for the main reasons for this development, various arguments can be found in the literature. The following factors are the most frequently named:

- Gulf War
- Recession
- Globalization of trade and industrial cooperation
- Decentralization of organizations
- Increased competition in almost all industrial areas
- Productivity and time pressure
- Telecommunications technology advances
- Relative costs of videoconferencing versus travel
- Social acceptance of new technologies

The Gulf conflict in 1991 and the associated fear of terrorism in the international aviation is widely seen as a main turning point and initiator of the accelerated market penetration and adoption of videoconferencing systems in the last few years.

During the Gulf conflict, videoconferencing traffic in some key markets rose by up to 400% (Arvai 1994: 8). AT&T reported at this time a 100% increase in requests for video linkups, while U.S. Sprint's meeting channel saw a 600% rise. Businesses "forced" to use videoconferencing during the Gulf War as alternative to travel in order to maintain business relationships recognized the effectiveness and efficiency of this technology as business tool and have continued using it -- in an even more extensive form -- in the subsequent years.

However, there are also studies analyzing the adoption of telecommunications during the Gulf conflict and their relationship to business travel (Erdal, Hallingby 1992) which come to the conclusion that only a marginal diversion of potential business travel to telecommunications occurred, particularly to videoconferencing (see also section 4.2.2). With respect to the high growth rates of videoconferencing linkups described above, one would have to acknowledge the low pre-war levels which these figures are based on.

But, it must be considered that accessibility to and network development of videoconferencing services at the time of the Gulf War were still very limited and, therefore, an immediate adoption of videoconferencing as alternative to travel for most businesses was not possible, particularly outside the U.S.

Global economic trends, especially the recessions at the beginning of the 1980s and 1990s, are also seen as significant drivers of a wider adoption of videoconferencing systems. In both cases, considerable business travel cutbacks were visible. Companies started to look for alternatives to travel and often initiated first pilot projects and then further information system expansions involving videoconferencing. This also reflects the prime incentive of early adopters to replace travel rather than to formulate more strategic objectives associated with the implementation of videoconferencing facilities.

Moreover, at least two characteristics of the changing business environment have also clearly been contributing to the increased need for communication systems like videoconferencing: the increasing importance of information as an economic resource necessary for the competitiveness of a company, and the growing significance of conducting business over distance due to the tendency toward dispersion of production and distribution activities to multiple sites (Salomon, et al. 1991: 293). Today's marketplace shifts more and more toward global cooperation and competition.

In addition, companies in an increasingly competitive environment have to be concerned about productivity and time pressure. This way cause them to assess and use videoconferencing as an important strategic tool.

Telecommunications technology advances, a radical change in the relative cost relationship between videoconferencing and business travel, as well as increased social acceptance of modern telecommunications as a way to communicate and to

"meet" are additional important contributors to the accelerated pace with which videoconferencing has been penetrating the market in recent years.

Most of the factors stated above, particularly the latter ones, are subject of a more detailed discussion throughout the subsequent sections of the thesis.

3.2.3 Today's Perspectives

The videoconferencing market is probably the most quickly growing telecommunication market these days. The annual growth rates in the last few years range from 40% to 50% and projections for the near future are at least at these levels.

There are several factors contributing to the continued generation of new interest in videoconferencing: Market expansion and increases in competition have led to rapidly declining costs of videoconferencing equipment and transmissions; improved standardization now provides wider interoperability of different systems and services; network growth is associated with wider accessibility and increased communication opportunities; new compression techniques, more sophisticated codecs and communication infrastructure improvements (expansion of fiber optics network) guarantee improved transmission qualities and speeds; integration of video systems into existing office systems and movable -- or even desktop systems -- have increased the convenience and flexibility of use and open new opportunities for applications.

Furthermore, strategic and competitive considerations in each industry, as well as the potential of direct travel cost and time savings continue to be important drivers for the adoption.

According to many videoconferencing industry analysts, videoconferencing has proven to be cost effective. Companies hesitating to adopt to videoconferencing due to the assessment of missing cost efficacy neglect the strategic benefits, which shifts them into a disadvantageous competitive position relative to competitors who have learnt to effectively use this technology.

Nevertheless, as discussed later in section 3.8, in spite of the promising developments stated above, significant hurdles remain, particularly in the areas of data transfer (deficiencies in communications network infrastructure), video-audio quality ("jerky" motion videos), standardization (interoperability problems), and even cost.

Finally, it is important to address that the rate at which videoconferencing is adopted depends, to some extent, also on regulatory action (Arthur D. Little 1993: 6-20). Regulatory policies in Canada and the U.S. have already positively influenced the development and utilization of telecommunication services. Deregulation has induced a more competitive environment -- particularly in long distance services -- resulting in diversified and improved services at reduced cost (Khan 1987: 11).

With respect to the telecommunication infrastructure ("information super-highway"), the state can take policy actions that would speed upgrading of its communication underpinnings through regulatory change that would encourage actions by private enterprise (Arthur D. Little 1993: 6-21). A fully developed fiber optics network would provide the data sharing and data transfer backbone that would eliminate or at least substantially overcome the problems created by lack of compatibility, data transfer speeds, etc. (Apogee 1994: 27). Cost estimates for such a nationwide fiber optics network (100% penetration) range from \$150 to \$200 billion (Arthur D. Little 1991: 3, 61).

3.3 Videoconferencing Technology and Systems

This section provides a more technical overview of videoconferencing. The most important aspects and concepts in the areas of infrastructure, compression technology, equipment, standardization, and existing videoconferencing systems are addressed. For more detailed information regarding the topics discussed subsequently, the references to professional telecommunication and videoconferencing literature provided in this thesis should be used.

3.3.1 Infrastructure and Network Services

The present telecommunication infrastructure still contains hurdles for the transmission of the vast amount of data associated with full-motion video images. Existing local telephone networks, residence and business internal telephone wiring, and low speed local area computer networks are limited in their capability to handle large data of high speeds (Apogee 1994: 23; Arthur D. Little 1993: 3-56/57).

Local Access Links:

Probably, the biggest problem is the provision of uninterrupted high-performance linkages between end users' devices and the digital long distance networks, which use fiber-based or other media supporting digital technology, such as coaxial,

microwave, or satellite. The dedicated local access links between end users and long distance carriers' centers, known as "Points of Presence" (POP), are normally in form of lines with capacities of 1.544 mega bits per second (Mbps), or 56/64 kilo bits per second (kbps).

Customers selecting an 1.544 Mbps (T-1) service divide this capacity into usable increments of 56/64 kbps or 384 kbps. Some portion is used for videoconferencing, and the rest for voice and data transmission. This flexible combination of access lines depending on the application requires a device called an inverse multiplexer that combines the different bit streams into the 1.544 Mbps digital signal. The long distance exchange carrier transports the signal through its network and delivers it to another access line (Daly 1994: 75).

A similar arrangement exists for switched 56/64 kbps access links -- note: a 56 kbps line differs from a 64 kbps line since that one slot (an 8-bit Data Service Unit [DSU], timing signal) is used for synchronization of transmission signals, a sacrifice of data carrying capacity not required in an Integrated Service Digital Network (ISDN). Since most video applications require at least one 56/64 kbps link for video and another for audio, at least two switched 56/64 kbps lines have to be available. It is possible to combine the capacity of numerous access lines to create any amount of data-carrying capacity. Nevertheless, because the current cost of three switched 56/64 kbps access lines is approximately the same as a T-1 service, switched 56/64 kbps services are usually limited to videoconferencing at 112/128 kbps (Daly 1994: 75-76).

Significant progress around the U.S. has been made in recent years with almost all local telephone company offices and many major businesses using an optical fiber hookup (Arthur D. Little 1993: 3-56). Nevertheless, wider network upgradings are still essential. Technologies that offer the prospect of breaking down existing barriers for a broader access to videoconferencing services are the continuously advancing compression technology (see 3.3.2), ISDN, and the already widely developed cable TV infrastructure (Arthur D. Little 1993: 3-57).

ISDN is a worldwide telephone network based on an all-digital format. While fairly well developed in Europe and Japan, ISDN is lacking development in the U.S. and Canada where most existing videoconferencing services are still based on switched 56/64 kbps telephone lines.

The cable TV infrastructure would also be able to support most videoconferencing transmissions. However, it has not been made accessible yet for this kind of services.

As stated before, digital compression is essential for the viability of videoconferencing. For this reason, the majority of networks now established for supporting videoconferencing are digital. They are either based on a primary data rate of 1.544 Mbps (T-1) or the basic block of digital transmission, 56/64 kbps (Daly 1994: 73).

Private Networks:

Videoconferencing networks are usually distinguished as private and public networks. Private lines are generally provided as fractional T-1 trunks. These private networks are very efficient since the high quality digital transmission is less costly than equivalent voice and data services acquired individually. Private networks offer the most flexible transmission alternative for videoconferencing. Bandwidths for video, audio, and data are provided on demand depending on the application.

The network costs are not usage sensitive implying that monthly private line expenses remain essentially constant. Therefore, a trade-off must be based on consideration of anticipated usage against the cost of alternative public transmission services. For larger corporations where weekly utilization exceeds 30 hours per location or which existing data and voice network has excess capacity usable for video, a full-time private line network is normally justifiable. On the other hand, most smaller companies with lower usage frequencies prefer pay-for-use alternatives, e.g., switched services (Daly 1994: 73; Halhed June 1993: 32-33).

A significant disadvantage of private line networks is their limited connectivity. The only locations that can conference are those on the network. Therefore, it is primarily used for intra-company conferencing. Nevertheless, even this can be overcome by adding an access to a public occasional-use network -- but at additional cost making dedicated private networks less cost-efficient for an increasing number of multiple sites (Daly 1994: 73).

Public Networks:

Public networks are classified by the way connections are established: "reservation" or "on demand". Using reservations-based services, appointments for conferences have to be made with the reservation center of a long-distance

exchange carrier, which then verifies the availability of the network connections. Switched services, on the other hand, allow the setting up of a video meeting on demand, in a similar way that a dial-up telephone call is made.

Switched network connections may be made at data rates of 56/64 kbps or 384 kbps. Generally, users prefer to choose the data rate of a videoconference on a call-by-call basis. For this purpose, increments of 56/64 kbps ($N \times 56/64$ kbps) are combined to achieve the operating data speed appropriate for the application. When separate 56/64 kbps connections are dialed up, an inverse multiplexer is needed as additional device. On the other hand, videoconferencing at a 384 kbps rate routed through the network as a single block has proven to be less popular (Daly 1994: 76).

An emerging option for switched networks is, of course, ISDN with its two types of network access. The Basic Rate Interface (BRI) comprises two 64 kbps data channels (B channel) and a 16 kbps dialing channel (D channel) and will be used primarily by smaller businesses, while the Primary Rate Interface (PRI) as a 1,544 Mbps access consists of 23 B channels and a 64 kbps D channel, and will be an attractive alternative for larger companies (Daly 1994: 77).

3.3.2 Compression Technology and Basic Equipment

Codec:

The "heart" of the digital videoconferencing system architecture is the codec (coder/decoder). Signals from all connected locations are passed to such a device. Most codecs use proprietary algorithms to convert analog information into a digital format, compress digital signals, and pass coded digitized information to a network access device for transmission.

Compression schemes necessary to transfer the extensive amount of video data associated with full-motion images through a limited network capacity have advanced considerably throughout the past several years. High-quality video is now feasible at bandwidths as low as 112 kbps. With today's compression technology, a video meeting held at 112 kbps is comparable in quality to one held a few years ago at 384 kbps and, of course, is thereby associated with a significant reduction in transmission costs (Finn, Galanin October 11, 1993: 41).

Nevertheless, most current compression technologies transmit only about 10 to 15 frames per second, which is significantly below the succession of TV pictures at

30 frames per second. Several codecs may be able to generate 30 frames per second when the picture contains a person sitting still and talking. However, increased gesticulating or other rapid motions cause the actual frame rate to decline since motion compensation is still widely lacking (Finn, Galanin October 11, 1993: 44).

Surprisingly, the video image is not the toughest part of the transmission with respect to user satisfaction. Voice quality experienced by telephone is hardly met in most of today's videoconferencing since the system must also digitally encode and compress voice data in the same capacity-limited signal as the image (Kupfer December 28, 1992: 91).

Until recently, various manufacturers were developing incompatible codecs to address various system requirements. Nevertheless, while costs of bandwidth decline, manufacturers are now developing a standard codec architecture to support an entire product line. Through economies of scale, improvements in codec technology will come to even lower costs (Finn, Galanin October 11, 1993: 42/48).

Nevertheless, among videoconferencing experts, there is a wide consensus that the compression methods used by most of today's codecs have reached their functional limitations. This implies that future gains in compression will be on the order of 20% to 30% over previous algorithms rather than the 200% to 300% improvements observable in recent years. However, with cost of communications bandwidth further declining, and new capacity becoming readily available in the U.S., further advances in compression technology are also less essential (Finn, Galanin October 11, 1993: 48).

Other Basic Equipment:

After discussing function and role of codecs, other elementary components of a videoconferencing system should be briefly introduced.

Multipoint conferences can be established by accessing the common carriers' network-embedded multipoint control units (MCU). These installations generally use their own codecs with proprietary coding technology. MCUs can also be purchased as part of a videoconferencing system leading to more independence from the common carriers' bridging services. This is particularly preferable for companies anticipating a high volume of multipoint meetings.

The camera usually located above or beside the monitor is pointed at the conference table and transmits images of local participants. Movement, pan, tilt, zoom, and focus are adjusted automatically using a voice detector, or manually via a control panel. Also increasingly used is a camera control allowing remote users to manipulate the camera at the other end of the conference line (Finn, Galanin October 11, 1993: 43).

The companion issue to the camera is the monitor. In a dual-monitor set up, remote participants appear on one monitor while graphics being sent or received are shown on the other monitor. In a single-monitor set up, graphics are viewed in a small window and remote conferees in a larger one or vice versa on the same monitor.

Microphones are usually spread across the conference table or are placed near the control panel. Local participants can mute them to speak privately. Speakers are generally located above the monitor and next to the camera (Finn, Galanin October 11, 1993: 43).

The problem with voice quality in a digital videoconference has already been discussed briefly. An important device to improve sound quality is an echo canceler that edits out unwanted noise. Acoustic echo is created when speech from a speaker at one site is picked up by a microphone at this site and rebroadcast to its origin or the other sites. Echo cancelers create an acoustic model of the room, and compensate accordingly (Finn, Galanin October 11, 1993: 41).

The support of videoconferences by graphical tools has already been subject of the discussion in section 3.1. The simplest equipment used for such support is a document stand with a vertical camera that transmits images placed on its surface.

3.3.3 Standards and Interoperability

Compression algorithms, communications framing, and call set ups have widely been kept proprietary by manufacturers. Therefore, interoperability between incompatible videoconferencing systems of different vendors cannot be achieved without further support devices. Such videoconferencing bridges are provided by long-distance exchange carriers and some vendors. However, using these bridges degrades the quality of reception.

In the recent past, carriers, vendors, users, and other groups involved in the videoconferencing market have started to work out concepts and definitions

targeted at standardization of codecs, transmission and projection algorithms, and have been testing interoperability. Undoubtedly, significant advances have been made in this area.

The H.320 standard from the International Telecommunications Union (ITU-T) is the most important international standard. It has also been rapidly gaining acceptance in the U.S. although most codecs in this country still rely on proprietary audio-video coding methods (Halhed November 1993: 33-34). The H.320 standard defines how the codec codes video, audio, and graphics, how the code should be transmitted, and how it has to be displayed during point-to-point and multipoint video sessions (Long February 1993: 35-39).

Nearly 90% of the video codecs in use outside North America comply with the H.320 standard. Since this level of standardized equipment in use has not been accomplished in the U.S. yet, interoperability problems between codecs are highly evident for users in this country, particularly in the international area. Furthermore, even compatibility problems among older and newer H.320 codecs are apparent (Halhed November 1993: 33-34).

The problem of interoperability is also significant in the newly emerging area of desktop videoconferencing where several applications do not support H.320 standards and are highly limited in their network connectivity. However, the development of specifications to create desktop video standards is on the way (Fitzgerald February 7, 1994: 41).

3.3.4 Videoconferencing Systems

Videoconferencing systems are usually categorized as boardroom, portable (roll-about), and desktop systems (see Table 3.3.4-1). Also, a classification into group and personal systems can be found in the literature. While group videoconferencing systems are designed to handle meeting sessions typically held in conference environments where several people are attending, personal systems enhance the person-to-person communication (Long February 1993: 35-39). Boardroom systems definitely belong to the first group of systems whereas desktop applications are undoubtedly person-to-person systems. Rollabout units, on the other hand, could be assigned to both categories since they are usable for small group, as well as personal meetings.

Videophones are not included in this discussion. The market for videophones, particularly for business applications, is evaluated as limited. Videophone systems -- already dropped in price to \$1,000 and less -- offer an inferior, small-size picture without synchronization of lip movements (New York Times January 11, 1993: 2). In addition, considering the rapidly declining prices and increasing quality of other videoconferencing systems, the videophone is generally not assessed as being a significant future tool for business teleconferencing.

The classification into two-way audio-video point-to-point, one-way video, two-way audio multipoint, and two-way audio-video multipoint has already been stated. Although multipoint-interactive video where any participant can originate and receive video and audio is now rapidly developing, one-way video, two-way audio systems for multipoint meetings are common.

Table 3.3.4-1: Comparative Overview of Videoconferencing Systems

Boardroom	Rollabout	Desktop
<ul style="list-style-type: none"> ☒ Group systems ☒ Fixed room systems ☒ Highest frame rates and best motion compensation ☒ Price range* : \$30,000 - \$90,000 ☒ Lowest future growth potential 	<ul style="list-style-type: none"> ☒ Personal and group systems ☒ Portable systems, can be wheeled from room to room ☒ Mostly of similar video quality as boardroom systems ☒ Price range* : \$15,000 - \$70,000 ☒ Currently the fastest growing market 	<ul style="list-style-type: none"> ☒ Personal systems ☒ PC-based or LAN-based systems ☒ Quality inferior to larger systems; still wide limitation in applications (lacking interoperability and multipoint capability) ☒ Price range* : \$2,000 - \$7,000 ☒ Market of the future

* : includes only unit price and installation of basic conference system and codec; additional costs have to be considered for network access, multipoint control unit (MCU), inverse multiplexer, room modifications, furnishing, and different optional equipment.

Boardroom Systems:

Boardroom systems -- also known as integrated room systems -- are at the high-end of the videoconferencing market with prices well into the six-figure range, including all supplementary and optional equipment. These systems are usually installed permanently in large conference rooms with optimum lighting and

acoustics at a major business location (Finn, Galanin October 11, 1993: 41-42). For the future, life-size screen projections that give the visual impression of sitting with conference partners at the same table are expected. Nevertheless, boardroom systems are generally regarded as having the lowest future growth potential. They might find a niche as rentable services from a commercial vendor located in large office buildings, or complexes, and thereby be accessible by businesses in the local area.

Rollabout Systems:

Rollabout systems can be wheeled around from room to room and are in the price range of \$25,000 to \$70,000. These units include a single monitor and camera, some peripherals, and a choice of compression algorithms. Newly introduced are rollabout units that work out to be cheaper than \$20,000. These units feature the same basic circuitry as their higher priced counterparts but usually offer smaller monitors and come in a configuration comprising fewer compression algorithms and network interfaces. Rollabouts are currently the fastest growing videoconferencing market (Finn, Galanin October 11, 1993: 41-42).

Desktop Systems:

Desktop videoconferencing is a mix of competing technologies, containing PC-based units and stand-alone videophones. The benefits of desktop videoconferencing are its flexible and uncomplicated use allowing quickly prepared face-to-face meetings and the ability to collaboratively view and change graphics and other data files.

Generally, two forms of desktop videoconferencing are distinguished: PC (personal computer)-based and LAN (local area network)-based videoconferencing. PC-based desktop systems add a small camera and board-based codec to existing PCs. The PC monitor is used to display video images and document files, while sound is generated on an attached speaker or through a voice board. LAN-based videoconferencing is basically a PC-based desktop video application utilizing LAN connections for video transport (Finn, Galanin October 11, 1993: 41-45).

These forms of low-cost video (prices between \$2,000 and \$7,000) often have significant limitations. Several systems lack network support, contain no-cross platform capabilities (to some extent not meeting H.320 standards), depend on ISDN, have no echo-canceller, and provide only point-to-point capabilities. Further-

more, video image quality is still inferior, so that most businesses currently do not see desktop videoconferencing as a real face-to-face substitute. Main applications are text-centered meetings relying on graphics and data sharing. Essentially, that means that desktop videoconferencing is widely assessed as an upgrading of conventional computer conferencing through video add-in features.

For the near future, open specifications and support of H.320 standards for desktop applications are expected to develop, improving interoperability, as well as multipoint capability (Blackwell November 1993: 89-92; Fitzgerald January 31, 1994: 12; Fitzgerald February 7, 1994: 41; Francis October 1, 1993: 48-51; Messmer January 31, 1994: 4,9).

3.4 Costs of Videoconferencing

Videoconferencing is now a diminishing cost market. The costs of equipment and transmission have fallen so much in recent years that investment is often justified solely through travel savings with a payback period estimated at one to two years. However, as the discussion throughout subsequent sections shows, the relationship between videoconferencing and business travel is much more complex than a simple cost trade-off.

In this section, the focus of the discussion is on the remarkable cost reduction of videoconferencing equipment and transmission. A more detailed analysis of all cost components to be considered in an investment decision is provided in section 4.3 when the trade-off between videoconferencing and business travel is addressed.

3.4.1 Equipment

Past:

Before the real breakthrough of videoconferencing in the late 1980s and early 1990s, videoconferencing for business purposes was almost exclusively limited to boardroom systems. The prices for equipment and installation of such integrated room systems were -- depending on supplementary and optional devices -- between \$500,000 and \$1 million in the early 1980s. The costs of codecs, significantly less developed at this time, ranged from \$200,000 to \$250,000. And, even five years ago when portable systems started to penetrate the market and significantly contribute to the increasing acceptance of this communication technology, start up

costs for most of these low-end, portable units were still in the order of \$100,000 (Feldman 9/93: 45; Gold 1989: 3-4; Wakin March/April 1994: 30).

Early desktop videoconferencing units penetrating the market about two years ago were priced at \$5,000 to \$10,000, a cost too high to promote the market acceptance of this form of videoconferencing in the last years (Finn, Galanin October 11, 1993: 45).

Table 3.4-1: Development of Videoconferencing Equipment and Transmission Costs

	Equipment	Transmission
<i>Past</i>	<ul style="list-style-type: none"> ➤ Early 1980s: Price for equipping a videoconferencing room \$500,000 to \$1 million; codecs listed between \$200,000 to \$250,000. ➤ End of 1980s: Lowest start up costs for a full-motion, color picture rollabout unit still about \$100,000* . ➤ Early units of desktop video systems, two years ago, between \$5,000 and \$10,000. 	<ul style="list-style-type: none"> ➤ Early 1980s: Hourly transmission rates of full-motion video for a coast-to-coast conference in the U.S. ranged from \$1,000 to \$4,000 depending on transmission bandwidth and service.
<i>Today</i>	<ul style="list-style-type: none"> ➤ Boardroom systems available for less than \$100,000* . ➤ Rollabouts typically ranging from \$30,000 to \$40,000* ; newest low-end units listed under \$20,000* ; larger systems with more features and higher quality for \$60,000 to \$80,000* . ➤ Cheapest desktop systems between \$2,000 and \$2,500; more sophisticated systems listed at around \$6,000. 	<ul style="list-style-type: none"> ➤ Hourly transmission costs for a coast-to-coast conference using 112 kbps switched digital services are between \$20 and \$30; almost doubling with 384 kbps transmission. ➤ International area: U.S. - Europe/Pacific Rim, hourly transmission charge for 112 kbps switched service of around \$500 to \$700.

cont'd on next page

Table 3.4-1 (Cont'd): Development of Videoconferencing Equipment and Transmission Costs

	Equipment	Transmission
<i>Future</i>	<ul style="list-style-type: none"> ➤ Continuously falling prices, particularly in the area of rollabouts and desktop systems. ➤ Rollabout units expected to be available at around \$5,000* in the year 2000. ➤ Desktop video add-in boards expected to drop to \$1000 - \$1,500 in the next 12 months; first units listed at about \$500 at the end of next year. 	<ul style="list-style-type: none"> ➤ Further cost decreases projected, especially in the international area; no quantified estimates found.

*: includes only unit price and installation of basic conference system and codec; additional costs have to be considered for network access, multipoint control unit (MCU), inverse multiplexer, room modifications, furnishing, and different optional equipment.

Present:

Today, the costs of boardroom systems -- only acquisition and installation of basic system and codec -- have fallen below \$100,000. High quality systems with certain additional features are still in the order of \$150,000.

Most rollabout videoconferencing units, representing the currently fastest growing market segment, are priced between \$30,000 and \$40,000. Newly released systems have even fallen below \$20,000. Larger systems with more features and higher video quality operating at 384 kbps or even higher bandwidths are typically listed between \$60,000 and \$80,000 (Finn, Galanin October 11, 1993: 41-42; Francis October 1, 1993: 48; Hughes February 8, 1993: 31).

Furthermore, leasing of rollabout units is a popular alternative for corporations. Today's lease rates range between \$500 and \$1,000 per month (Ridgway April 1993: 2; Wallace May 24, 1993: 27).

Video add-in boards for PCs are already available for \$2,000 - \$2,500. However, as discussed in 3.3.4, these low-cost systems are lacking in terms of interoperability, multipoint capability, and picture and sound quality. More sophisticated desktop video systems are listed at \$5,000 to \$7,000 per unit. The

average price of systems being shipped declined from \$7,500 in 1992 to \$5,000 in 1993. Estimates for this year expect an average system price of \$3,400 (Burch September 27, 1993: 32).

Future:

Continuously falling prices for videoconferencing equipment, transmissions and services are also anticipated through the end of the decade. This applies particularly to the rollabout and desktop markets.

Rollabout units are projected to be available for as low as \$5,000 in the year 2000 (Hughes February 8, 1993: 31) while the costs of video add-in boards for desktops, the market assessed as having the largest future growth potential, are expected to be in average below \$1,000 in 1997 (Burch September 27, 1993: 32).

The cost range of \$1,000 to \$1,500 for desktop applications is expected to be reached by mid-1995, and first systems available for even \$500 are projected for another 6 to 12 months later (Fitzgerald February 7, 1994: 41). This price level is seen as being imperative for a wider deployment of desktop videoconferencing. Users would order video add-ins as option for PCs just as customers today do with modems for data connectivity (Burch September 27, 1993: 32).

A summary of these cost developments is provided in Table 3.4-1.

3.4.2 Transmission

Overall transmission costs contain usually access charges and variable transfer costs on an hourly basis. For multipoint meetings using bridging services of exchange carriers, bridging costs per location are charged in addition to the individual transfer costs between the carrier's video center and the connected sites.

Transmission costs are dependent on the chosen bandwidth and transfer speed, as well as on the service provided by the long-distance carrier -- if a public network is used. Furthermore, the level of utilization can imply certain volume discounts. As in case of conventional telephone services, also time dependent charges apply. When private line networks are used, costs are almost insensitive to the actual utilization and are incurred as monthly constants.

Hourly Transmission Charges:

In most of the literature comparing past and current transmission charges, different transmission services and speeds are not carefully distinguished and average values are provided. Figures of hourly transmission costs in the early 1980s vary between \$1,000 and \$4,000 for full-motion coast-to-coast videoconferencing (Edelman July 19, 1991: 53; Gerety January 27, 1992: A7; Gold 1989: 3-4; Tealeb, Orton 1985: 8).

Competition, growth of demand, advances in technology, and upgrading of the infrastructure have caused continuously falling costs of transmission during the last 10 years. Furthermore, a better variety of services is available. There are now significant differences in price with respect to various services of the carriers and the transmission bandwidth being selected.

Today, there has been an order of magnitude change in the transmission costs, with the least expensive video rates approximating telephone call cost levels. Using switched digital services of long distance carriers, coast-to-coast videoconferencing (point-to-point) in the U.S. now is possible for as low as \$20 to \$30 an hour using 112 kbps. Increasing the transfer speed to 384 kbps would almost double these hourly charges. Reserved digital services are associated with significantly higher costs, ranging from \$230 per hour for coast-to-coast conferencing at 384 kbps to \$420 using 1.544 Mbps.

In the international area, hourly charges are usually imposed by the carriers of all participating countries. For switched digital services between the U.S. and Europe and the Pacific Rim, respectively, the U.S. exchange carrier charges about \$300 an hour for 112 kbps. However, this is only a half-circuit charge. The involved overseas carrier imposes an additional charge, leading to overall hourly transmission costs for a point-to-point meeting of \$500 to \$700 using 112 kbps. International transmission costs significantly increase with higher bandwidths, or the use of reservations-based services (AT&T 1994; AT&T Global Business Video Services).

For multipoint services, different charging schemes are applied by the long-distance exchange carriers. In case of AT&T, individual point-to-point transmission rates between the connected sites and the AT&T Video Center in Atlanta are cumulated and bridging charges (around \$60) per location added. U.S. Sprint, on the other hand, charges flat rates up to a certain number of sites connected. Also, for connections between incompatible systems, extra bridging charges are incurred

by users. When customers have systems with their own integrated Multipoint Control Unit (MCU), the public carriers' bridging services are not needed for multipoint meetings. Only the incremental point-to-point charges for transmission between the site having the MPU and the others have to be cumulated.

Monthly Local Access Charges:

High variations in price are also evident with respect to the network access forms (see discussion of different forms in section 3.3.1). The costs of these network linkages do not only vary among the different bandwidths that can be chosen but also on a regional basis since the access length depends on the state of development of the regional network and the location of local "Points of Presence" (POP).

While 56 kbps lines are available for a monthly cost of as low as \$30 to \$100 per line, costs for T-1 lines are usually in the order of \$200 to \$1,000 a month. Accessing to ISDN depends on the interface type. For BRI, costs are at the level of those of 56 kbps lines or even lower while a PRI access is associated with monthly costs up to \$500 above corresponding T-1 access charges.

A summary of the historical and projected development of transmission costs is provided in Table 3.4-1.

3.4.3 Public Videoconferencing Rooms and Services

Companies not having in-house systems or in need of additional video services can rent public videoconferencing rooms, most of them operated by long-distance carriers. In addition, during the last few years, several hotel chains and various local firms in major business locations have entered the videoconferencing business and are increasingly offering videoconferencing facilities. The copy center chain, Kinko's Service Corp., has started integrating video services in a large number of its about 600 copy centers nationwide.

Hourly rentals of low-end room systems -- basically rollabouts -- range from \$150 to \$250 for 384 kbps point-to-point meetings. For larger room systems, the rates are in the order of around \$350 per hour. In all cases, cross-connections to other carriers' networks and between incompatible equipment of different vendors are available for additional costs of \$30 to \$60 (Burch September 27, 1993: 32; Ramirez September 15, 1993: 5; Rosen May 16, 1994: A1/A16; Wexler September

27, 1993: 74; Randy Doyle, responsible for Kinko's videoconferencing marketing: phone conversation with author).

Besides the usage of public videoconferencing rooms, companies without their own in-house systems also have the alternative to temporarily install systems in their company's conference rooms. Vendors, such as PictureTel, offer these rental systems and install the videoconferencing equipment temporarily in the corporate offices. Rental rates for these video services are usually higher than rentals of rooms in public video centers.

3.5 Videoconferencing Market

This section describes the videoconferencing market with focus on vendors and long-distance exchange carriers. Furthermore past, current and projected developments in videoconferencing sales and system adoptions are discussed.

3.5.1 Vendors

The dominant manufacturers in the North American and world videoconferencing market are in alphabetical order: Compression Labs, Inc. (CLI), GPT Video Systems (GPT), NEC, PictureTel Corporation (PTC), and VTel Corporation (VTel).

Compression Labs, the first North American codec manufacturer, was initially the market leader in the U.S. and worldwide. Meanwhile, PictureTel has taken this leadership with sales representing 40% of the world market (in units). Its world sales totaled about 3,600 videoconferencing systems and codecs in the 12-month period of 1992-93. (Halhed, Scott September 1993: 29-32). See also Figure 3.5.1-1.

Like its biggest competitor, Compression Labs, PictureTel's product line comprises all videoconferencing segments from sophisticated high-end integrated room systems and rollabouts to low-end rollabout systems (\$15,000 - \$20,000 per unit) and desktop applications.

VTel, the third largest manufacturer in the U.S. market, plans to develop a line of desktop products to complement its existing room and rollabout systems and, therefore, to match its competitors.

These three manufacturers -- PictureTel, Compression Labs, and VTel -- constitute about 85% of the U.S. market (Francis October 1, 1993: 48).

The largest non-U.S. videoconferencing vendor is U.K.-based GPT Video Systems. It was the first manufacturer to produce an International Telecommunications Union (ITU-T, formerly CCITT) - compatible codec. In third place in world sales volume, GPT is the market leader outside North America (Halhed, Scott September 1993: 29-32).

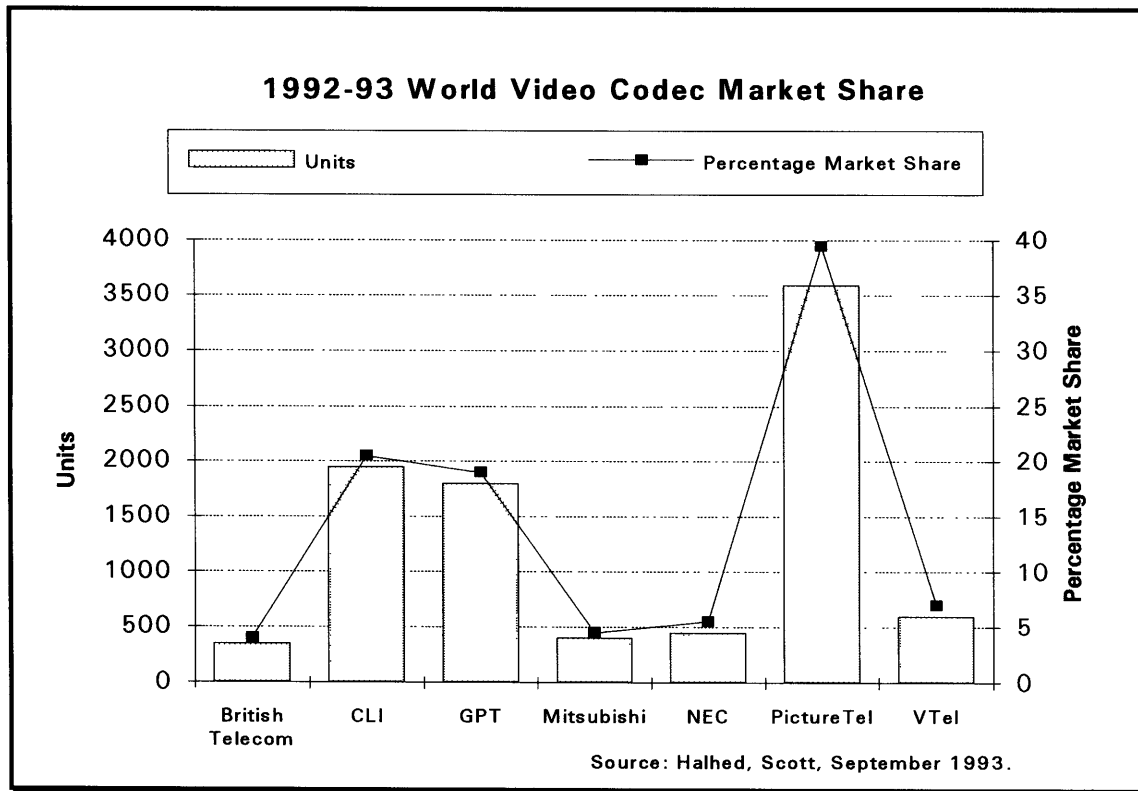


Figure 3.5.1-1: 1992-93 World Video Codec Market Share

Minor players in the international market and especially in the U.S. are still the Japanese manufacturers NEC and Mitsubishi. NEC was the first company in the world to produce video codecs. Mitsubishi is today the videoconferencing sales leader in Japan. Both firms have strengthened their sales and support forces to market new series of low-end ITU-T-compatible video systems in North America. These new product lines are targeted at the entry-level market that is currently monopolized by the U.S. market leaders PictureTel and Compression Labs (Halhed, Scott September 1993: 29-32).

Figure 3.5.1-1 exhibits the 1992-93 world market share, including sales revenue from proprietary codecs, ITU-T-compliant codecs and rollout systems incorporating codecs, for the seven leading companies in the global videoconferencing market. In 1992-93, ITU-T-compatible systems, including desktop

applications, accounted for more than 95% of all units being shipped (Halhed, Scott September 1993: 29-32).

The competition in the videoconferencing market is increasing. The dominant players, especially PictureTel and Compression Labs in the U.S., are under increasing pressure from both Japanese manufacturers trying to establish their low-end products in the U.S. market, and various newcomers, like Intel, challenging the current market leaders in the desktop segment.

3.5.2 Exchange Carriers

In the videoconferencing market, the dominant long-distance exchange carriers for U.S. domestic and U.S. international videoconferencing are AT&T and Sprint. Together, they carry almost 90% of all international videoconferencing traffic. Although the number of countries served by both carriers is continually increasing, each carrier reaches some countries that are not served by the other (Halhed November 1993: 36).

The other large U.S. long-distance exchange carrier, MCI, entered the videoconferencing market in 1993 by offering, like its established competitors AT&T and Sprint, a package of various reservations-based and switched digital services of bandwidths from 56 kbps to 1.544 Mbps for point-to-point and multipoint videoconferencing on domestic and international basis (regarding network services and costs see sections 3.3.1 and 3.4.2).

All carriers, furthermore, offer public videoconferencing services in their video centers spread across the country. Rooms can be rented for \$150 to \$350 per hour depending on the equipment and services being used (Burch September 27, 1993: 7/68; Halhed November 1993: 36-37; Wallace May 24, 1993: 27)

3.5.3 Past and Present Trends in Sales and System Adoptions

The enormous growth rates of the videoconferencing market in recent years have already been subject of discussions early in the paper. Now a closer look on the development of sales revenue and system installations should be made.

Worldwide sales of videoconferencing systems and services have been increasing an average of about 30% annually in the last two years while the rates of growth in North America have been even higher -- 57% in 1991, and 43% in 1992 over previous year. This growth was driven by the daily usage of almost

9,500 systems in North America, a near doubling compared to 1991. For the last year, an increase in revenues from equipment sales and network and transmission services of about 60% was estimated (estimate from mid-1993; see also Table 3.5.3-1; ITCA June 14, 1993).

According to the International Teleconferencing Association (ITCA), the North American teleconferencing industry had total revenues of \$1.75 billion in 1992 (codecs, equipment, and transmission services), representing a growth of 22.7% over 1991. Videoconferencing with its annual growth rates of 40% to 60% in recent years represents clearly the fastest growing segment of the teleconferencing industry including audio, video, and multimedia.

Since annual revenues have now exceeded \$1 billion in North America, videoconferencing constitutes about 50% of total teleconferencing sales revenue. Desktop video add-in boards, assessed as having the highest future growth potential, contributed with sales revenue of around \$70 million to the above figures (Hof et al. January 31, 1994: 69).

Table 3.5.3-1: Annual Growth and Total Sales Revenue (in Millions of Dollars) of Teleconferencing in North America

	1990	1991	1992	1993 Forecast
<i>Video (2-Way)</i>				
Codecs and MCUs	54.8%	28.3%	14.1%	
Room & noncodec equipment	38.3%	53.3%	34.0%	
Transport	54.0%	80.0%	64.9%	
Revenue (2-Way)	\$315.7	\$495.3	\$706.9	\$1,112.6
Revenue (1-Way Video)	\$157.6	\$208.3	\$195.8	\$203.0
Revenue (Audio)	\$537.0	\$647.3	\$770.0	\$938.6
Revenue (Audiographic)	\$68.0	\$77.1	\$79.4	\$89.1
TOTAL TELECONFERENCING	\$1,078.3	\$1,428.0	\$1,752.1	\$2,343.3

Source: International Teleconferencing Association (ITCA), 1993.

The boom of videoconferencing in the recent years is also emphasized by the development of units shipped per year -- see Table 3.5.3-2. While in 1987, worldwide only about 300 units were sold, the figures for 1993 are in the order of 13,000 (Earon 1993; Feldman 9/1993: 45).

The number of installed videoconferencing units worldwide has almost doubled in 1993 and is expected to exceed this annual growth rate in 1994. This trend is illustrated in Table 3.5.3-2 and Figure 3.5.3-1. While in 1989, less than 1,000 units were installed worldwide, around 27,000 videoconferencing systems were in use by the end of 1993. The number of units in operation in the U.S. at this time is estimated at 20,000 to 24,000 -- including roughly 11,000 desktop applications (Burch September 27, 1993: 32; Rosen May 16, 1994: A16).

These numbers also show the high share of the U.S. of the total videoconferencing market. Depending on accounting scheme applied, around 70% to 75% of all videoconferencing systems worldwide are in use in this country. However, also the growth rates in Europe and East Asia are accelerating, implying a falling U.S. share in the future.

Table 3.5.3-2: Worldwide Teleconferencing Market -- Annual Shipments and Installed Base

	1992	1993	1994	1995	1996
Annual Sales (Units)					
<i>Videoconferencing</i>	8,226	13,320	37,002	118,042	414,194
<i>Audioconferencing</i>	23,906	32,290	43,971	60,366	83,530
<i>Multimedia</i>	2,618	3,444	5,415	10,829	31,878
Installed Base (Units)					
<i>Videoconferencing</i>	14,151	27,471	64,473	182,515	596,709
<i>Audioconferencing</i>	105,523	137,813	181,784	242,149	325,680
<i>Multimedia</i>	14,867	18,310	23,725	34,554	66,432

Source: Telemanagement Resources International, Inc. (TRI), 1993

According to Telemanagement Resources International, in 1990, only the 50 largest U.S. corporations could afford videoconferencing. But now, with the remarkable cost reductions, the technology has spread to the top 1,000 companies and increasingly into mid-size and smaller businesses. And, the emerging desktop market is fostering this trend (Burch September 27, 1993: 32).

In 1992, around 1,000 U.S. organizations had already installed videoconferencing (Yankee Group; Feldman 9/1993: 44). It is estimated that today more than 50% of companies of the "Fortune 1000" group and almost 75% of the "Fortune 500" group have already adopted to some form of videoconferencing for business purposes.

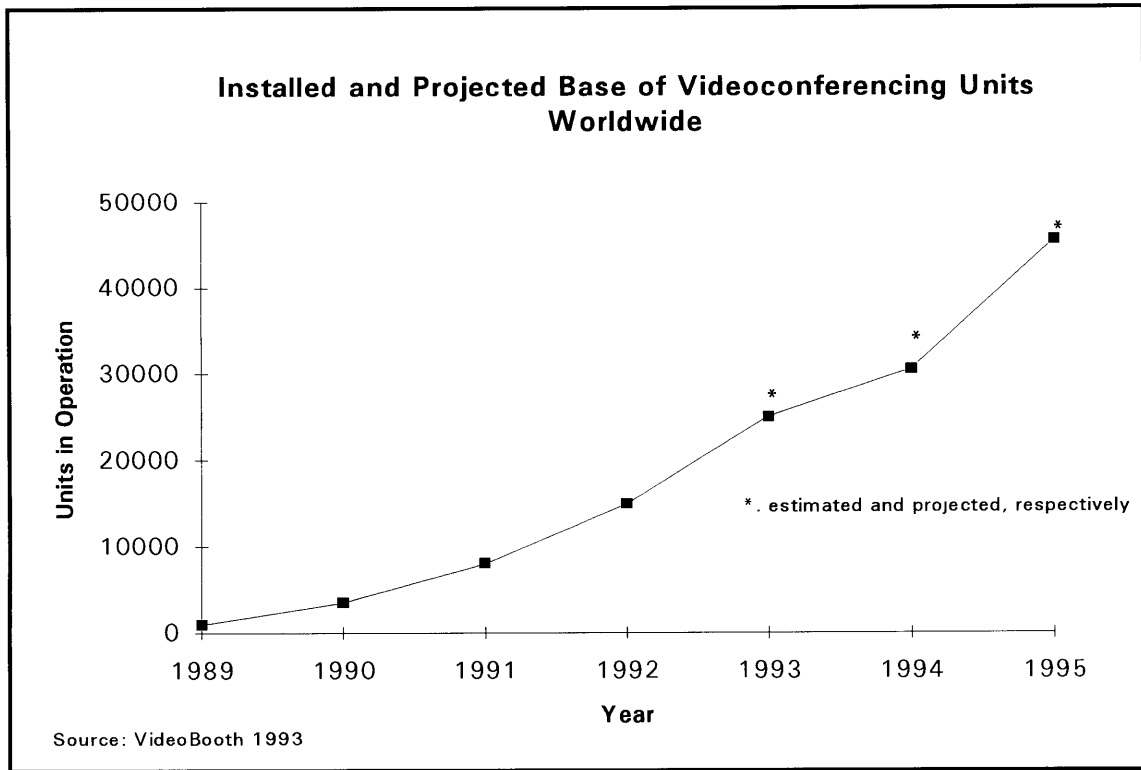


Figure 3.5.3-1: Installed and Projected Base of Videoconferencing Units Worldwide

3.5.4 Future Prospects

The high growth rates of the videoconferencing market in the recent past are expected to continue in the next several years, probably at even higher levels some experts believe. Growing competition, particularly in the low-end market (cheap rollabouts and desktop video) where established vendors are challenged by several newcomers inducing continually falling prices, an expanding international network offering wider connection opportunities, further improved technology widely complying with international standards, and especially the emergence of desktop video are seen as the main factors underlying these growth trends in videoconferencing.

Videoconferencing is expected to further penetrate into mid-size and smaller-size businesses, and also in the vertical hierarchy of organizations toward lower and junior management.

The videoconferencing growth appears nowadays to be self-generating and non-reversible. Corporations, already having installed an initial video base, are refining and expanding their capabilities in response to their employees claiming that they cannot work without it anymore. Changing business habits create new needs to

communicate with dispersed locations and business partners, which cause a continual expansion of corporate video capabilities (Svenning 1994: 4).

Table 3.5.4-1: Projections for Worldwide Revenues in Equipment, Network, and Services

1995	<ul style="list-style-type: none"> ➤ Worldwide videoconferencing revenues: \$3 billion (VideoBooth)
1996	<ul style="list-style-type: none"> ➤ Worldwide videoconferencing revenues: <ul style="list-style-type: none"> \$4.77 billion (Telemanagement Resources International) \$5.30 billion (Personal Technology Research) ➤ Worldwide teleconferencing revenues (incl. audio & multimedia): <ul style="list-style-type: none"> \$7.85 billion (Telemanagement Resources International) ➤ Worldwide market sales of videoconferencing <u>equipment</u>: <ul style="list-style-type: none"> \$1.60 billion (Compression Labs)
1997	<ul style="list-style-type: none"> ➤ Worldwide videoconferencing revenues: <ul style="list-style-type: none"> \$6.9 billion (North American Telecommunication Ass.) \$8.0 billion (various industry analysts) \$10.5 billion (Personal Technology Research) ➤ Worldwide <u>desktop video board</u> sales: <ul style="list-style-type: none"> \$2.5 billion (Gartner Group) \$3.4 billion (Personal Technology Research) ➤ Worldwide business spending on teleconferencing: <ul style="list-style-type: none"> \$13 billion (Inteco)

A wide range of forecast values for the growth of videoconferencing sales revenue including equipment, network, and services can be found. Table 3.5.4-1 shows projections of different industry analysts and consulting firms.

Most experts expect annual growth rates of 50% to 60% in the next three to four years. Some analysts and market researchers project even greater increases in the form of an exponential growth. Worldwide videoconferencing revenues are expected to reach about \$5 billion in 1996 -- compared to about \$1.4 billion in 1993. Particularly in the desktop segment, an enormous growth from today's \$70 million to \$2.5 to \$3.4 billion in 1997 is anticipated.

As Figure 3.5.3-1 and Table 3.5.3-2 show, different growth projections also exist for annual sales in units and the number of installed systems. While VideoBooth, Inc., expects a slight decline of the annual growth rate in 1994 (to

about 20%), Telemanagement Resources International, Inc. (TRI), suggests a more than doubling of the number of units being operated to over 60,000 throughout this year. Even higher growth rates are projected for 1995 and 1996 stimulated by the high unit sales in the desktop video area (Apogee 1994: 21; Blackwell November 1993: 90; Clark February 28, 1994: 20; Earon 1993; Francis October 1, 1993: 48; Heather January 1994: 6; Hof et al. January 31, 1994: 69; Kupfer December 28, 1992: 90; LaPlante September 13, 1993: 111).

3.6 Usage of Videoconferencing

This section discusses today's applications of videoconferencing and characteristics of videoconferencing adopters. It addresses the main motivations for an investment in this technology and the current level of satisfaction. Finally, a look is taken at established videoconferencing policies in corporations and organizations and at existing plans as regards future investment in videoconferencing facilities.

3.6.1 Adopters of Videoconferencing

Business and Governmental Organizations

As stated in section 3.2.1, governmental organizations and agencies, particularly in the defense sector and the NASA, were the first heavy adopters of early forms of videoconferencing. The business community started notably adopting to videoconferencing in the late 1980s and early 1990s, with large corporations as trendsetters.

Today about 50% of the "Fortune 1000" industry group and around three fourths of the "Fortune 500" companies in the U.S. use videoconferencing for business purposes. In addition, a significant number of companies of both industry groups currently not using this technology are evaluating the appropriateness of videoconferencing systems for their businesses (Feldman 9/1993: 44; Clark February 28, 1994: 20).

While early adopters in the business world were primarily companies in the high-tech area, corporations of the chemical and pharmaceutical industry, and firms in the financial and insurance sector; today, the trend of adoption is throughout all industries and businesses and can barely be specified as a characteristic of an individual industry sector.

More flexibly adaptable, low-end videoconferencing applications, such as roll-about systems and, particularly in the future, desktop video, contribute to the trend that videoconferencing is no longer a matter of company size and business characteristics. The technology is penetrating small and mid-size companies in basically all business areas. In today's global marketplace, such companies are finding they gain a competitive edge through videoconferencing and collaborative computing (Wakin March/April 1994: 30). These technologies allow small and mid-size companies to participate in the global market and do business on a wider geographical scale.

In addition, low-end videoconferencing systems also break vertical hierarchies and enable a wider adoption of videoconferencing by middle and lower management levels.

Simultaneously with this continuous increase in videoconferencing adoptions by the business community, governmental institutions have proceeded to integrate videoconferencing in their operations and activities. According to Hezel Associates (Feldman 9/1993: 48), the usage of videoconferencing in government has dramatically increased in the last few years. However, the travel impact -- if experienced -- is more highway-related than air-related.

M.I.T. Survey Results

Although videoconferencing is becoming a commonplace communication tool in the business world, even in companies already using the technology for several years, its adoption is limited to a small portion of employees. According to the survey for this thesis (Appendix 1; corporate questionnaire: 2b/3d), on average, only 1.8% (on average: 683 employees) of all company employees (on average: 38,843) are using videoconferencing. This may mean there is yet a large potential for expansion of videoconferencing activities within current corporate users. However, the low percentage understates the real importance of videoconferencing for a company's communications since the average number of videoconferencing users is put into relation to the overall workforce and not to that portion of employees normally in need of face-to-face business meetings.

Among the responses, significant variations in the number of employees already having adopted to this technology are evident, depending on the company's size, its type of business, organizational structure (e.g., number and location of sites), and geographical scope of business activities. In 57% of companies having responded, videoconferencing is used by less than 300 people. On the other hand, one out of

three companies stated that more than 1,000 employees are using videoconferencing (maximum: 5,000).

Of all corporate sites, on average, only 9.2% are equipped with at least one videoconferencing system -- cumulated for all responses: 289 sites out of 3,140. About 40% of companies responding have less than 10% of their sites equipped whereas one fourth has videoconferencing facilities at least in one out of three sites. Again, these figures emphasize that there may be a significant potential for further expansion of this technology at current corporate users.

3.6.2 Justification and Motivation for Adoption of Videoconferencing

As stated in section 3.2.1, for early adopters of videoconferencing, travel replacement was the primary driver for an investment in this technology. Today, customers are taking a more strategic view of the role of videoconferencing to improve their business and competitiveness. They pursue goals more sophisticated than mere travel savings (Gold 1989: 9; Saffo Autumn 1993: 116).

When asked for the main drivers of videoconferencing today -- besides travel substitution --, industry analysts and users name the following:

- Convenience and flexibility of management communications.
- Increased personal productivity and efficiency.
- Gains in competitiveness through faster and spontaneous decision-making, shorter time-to-market, and enhanced customer service and supplier contact.
- Enhanced business opportunities through effective partnering and team-working among dispersed locations.
- Reducing travel risk and meeting delay; particularly isolating company from Gulf War scenarios, associated with far-reaching effects on international business.

However, in spite of the increasing identification of these more strategic objectives, travel substitution remains a key driver underlying the investment decision. Though spurred by recessionary trends and increased pressure on travel budgets, this derives widely from the relative ease of the quantification of the benefits of travel replacement. Since putting figures on gains in productivity and competitiveness, often identified as potentially more significant benefits, is much harder, travel savings through videoconferencing are used as fallback. After the

investment, travel savings are often stated by companies as a less important factor. This aspect is subject of more extensive analysis throughout section 4, especially in 4.1.3, 4.2.2, and 4.4.1.

Most experts and users agree that the real value of travel substitution is in the cost of management time rather than in savings of out-of-pocket expenses associated with airline ticket, lodging, and meals. Svenning (1994) stresses that time is the organization's and manager's number one competitor and equivalent to money, productivity, quality, and even innovation. She suggests that the rapidly increasing adoption rate of videoconferencing and other enhanced telecommunications technologies over the last few years is a function of the fact that companies cannot afford to operate without such a time-saving tool. Also Bennison (4/1988: 295) identifies on basis of a videoconferencing user study time constraints on business as most important decision factor for videoconferencing acquisition.

Researchers suggest that the preferences of top executives are often crucial in determining the adoption to videoconferencing in a company (Salomon, Schofer 3/1988: 224; Gerety January 27, 1992: A7). In many cases, the move into video meetings may be done directly by the president or chief executives, whose views may be only partially affected by simple cost comparisons. Communication convenience, flexibility and effectiveness may be attributes of higher significance, and large monitors and high quality video transmission (at least 384 kbps) required features.

Elsewhere, the impetus may come from telecommunications specialists that have been studying the video market and recognized the cost effectiveness of this technology for their company. In several cases, researchers and/or engineers ask for videoconferencing systems to enhance communications. They may stress system features as interoperability and connectivity, and integration of external devices, such as whiteboard-sharing devices, rather than high video resolution.

According to a user survey by Personal Technology Research (1993), cost of videoconferencing is clearly the most critical factor that would determine the decision to extend corporate videoconferencing capabilities (for 45% of respondents). Connectivity (23%), performance features (18%), and immediate business needs (11%) are stated as next important criteria.

3.6.3 Systems in Use

The analysis of past and present developments, as well as of future prospects as regards sales and adoption of videoconferencing systems (sections 3.3.4, 3.5.3, and 3.5.4) has revealed the most characteristic trends. High-end boardroom systems were initially the basic form of videoconferencing, until, at the end of the 1980s and early 1990s, rollabout systems significantly contributed to the market breakthrough of this technology. For the future, desktop video is evaluated as having the highest growth potential.

The survey performed for this thesis (see also section 4.5) provides a picture of the current level of system adoption and the relative importance of individual videoconferencing types (see Tables 3.6.3-1 and 3.6.3-2; for corporate questionnaire, see Appendix 1, question 3a).

Rollabout Systems

Rollabout systems are most widely employed in the companies surveyed. From a total of 411 systems in use in all companies, 64% are rollabout units, from which more than half are capable to provide multipoint meetings -- most of those 2-way video-audio. However, only 30% of companies stated to have rollabouts for point-to-point meetings; and, only 34% of corporations reported to use rollabout units with multipoint capability. Overall, 48% of all responding corporations use some form of rollabout units.

Boardroom Systems

On the other hand, almost two out of three companies have in-house boardroom systems. About 35% make use of point-to-point systems while around the half of the companies have facilities for multipoint meetings. In terms of number of units in use in the survey sample, boardroom applications have, not surprisingly, a lower percentage share than rollabouts. Only 31% of all videoconferencing systems in the companies are boardroom systems.

The apparent significance of boardroom applications is also confirmed by the individual users of videoconferencing in the companies (Appendix 2; user questionnaire: 3c/d). About 50% of respondents reported to use exclusively boardroom systems when doing videoconferencing; two thirds stated to use those systems 75% or more of the total time spent on videoconferencing. Point-to-point applications seem to be still dominant, though, as stated above, the majority of

systems (58.6%) have multipoint capabilities. Eighty-three percent of respondents to the user questionnaire reported to most frequently conduct 2-way video-audio point-to-point conferences.

Table 3.6.3-1: Level of Adoption of Videoconferencing Systems: Availability in Survey Companies

	2-way video-audio point-to-point	2-way audio, 1-way video multipoint	2-way video-audio multipoint
Boardroom systems	35%	13%	35%
Rollabout systems	30%	4%	30%
Desktop systems	18%	-	4%
LAN-based systems	4%	-	-

Note: Percentages provided represent portion of responding companies using the specific type of videoconferencing; sums are greater 100% since companies may have multiple systems.

Source: Survey of videoconferencing managers conducted for this thesis (see Appendix 1).

Table 3.6.3-2: Level of Adoption of Videoconferencing Systems: Composition of Systems in Use in Survey Companies

	2-way video-audio point-to-point	2-way audio, 1-way video multipoint	2-way video-audio multipoint	Total
Boardroom systems	43 (10.5%)	27 (6.6%)	58 (14.1%)	128 (31.2%)
Rollabout systems	111 (27%)	40 (9.7%)	111 (27%)	262 (63.7%)
Desktop systems	16 (3.9%)	-	2 (0.5%)	18 (4.4%)
LAN-based systems	1 (0.2%)	-	-	1 (0.2%)

Note: Figures indicate cumulative number of systems in use in companies responding to survey; numbers in brackets represent relative portion of all systems in use in survey sample.

Source: Survey of videoconferencing managers conducted for this thesis (see Appendix 1).

Desktop Video Systems

The survey results also show that desktop video has not been notably adopted by the business community. Only 18% of companies stated to use desktop video, most of those only in form of pilot projects. One pilot project is also reported for multipoint desktop videoconferencing. The percentage share of desktop video units in the survey sample is 4.4%.

Systems per Company

The average number of videoconferencing systems in use per company is 19 (all types cumulated). More than 40% of companies have more than 16 videoconferencing units in use throughout the world. Three companies (14%) use more than 50 videoconferencing units of various kinds. On the other hand, 59% of corporations in the sample are equipped with 10 or fewer systems worldwide.

Daily Utilization

With respect to system utilization per workday (Appendix 1; corporate questionnaire: 3e), boardroom systems show the highest average utilization with 4.2 hours per workday (average of responses of all companies using this type of system). Rollabouts, on average, are used only 2.8 hours per day, while the companies reporting desktop video use stated an average daily utilization of 2 hours. The relative differences of these figures reflect the different usage patterns of these applications. Desktop video applications are personal systems and mostly used by one person. Rollabouts can be seen as both personal and group systems. However, in general they are accessible for a certain number of employees and scheduled among those during a workday. Boardroom systems are centrally located and usually used by different groups of employees throughout a workday, leading to the highest average utilization of the three kinds of videoconferencing.

3.6.4 Videoconferencing Satisfaction

Most surveys of videoconferencing users reveal that videoconferencing is satisfactory for a wide range of business communication purposes, many of them traditionally requiring in-person atmosphere. Some research (Economic Research Centre 1983: 33) even suggests that introducing a video image into a conventional audio teleconference makes little measurable differences to effectiveness as perceived by the users. However, videoconferencing expands the applicability of teleconferencing in the business community by supporting forms of business communication where face-to-face interaction is inevitable.

In a user survey by Svenning, Ruchinskas, and Hart (1993: 73/74; see also section 3.7.1), videoconferencing was rated as satisfactory for most business meetings by the majority of respondents (76%). Two thirds indicated they would use videoconferencing even more if facilities were available at short notice. Three

out of four see videoconferencing as a medium enabling and facilitating information sharing and cooperation over distances.

M.I.T. Survey

The importance of and satisfaction with different videoconferencing criteria were also subject of the survey of videoconferencing managers and individual users for the purpose of this study (Appendix 1 and 2; corporate survey: 8b; user survey: 6b). Participants were asked to rate several criteria of videoconferencing with respect to their importance for the company and individual user, respectively, and the current level of satisfaction by using a non-dimensional scale from 1 (minimum) to 10 (maximum). Table 3.6.4-1 shows the ratings averaged over the total responses.

Overall, the evaluations by videoconferencing managers and users reveal similar trends. Interestingly, users rated, in general, importance of and satisfaction with the individual criteria higher than the videoconferencing managers. In all cases, as expected, the average importance rating exceeds the satisfaction rating, revealing that deficiencies are still evident.

Table 3.6.4-1: Importance and Current Satisfaction as regards Different Videoconferencing Criteria

Criteria	Corporate Survey		User Survey	
	Importance	Satisfaction	Importance	Satisfaction
<i>Ease of use</i>	8.5	7.7	9.1	8.5
<i>Conformance to standards</i>	8.2	5.9	-	-
<i>Video performance</i>	7.8	7.1	7.9	7.4
<i>Audio performance</i>	8.0	7.7	8.7	7.5
<i>Video-audio synchronization</i>	8.0	7.2	8.8	7.9
<i>Cost</i>	7.7	6.7	7.8	6.7
<i>Interoperability</i>	7.6	5.7	8.2	5.5
<i>Support for external devices and file formats</i>	6.6	4.6	6.9	5.4

Note: Figures indicate average rating of respondents on a non-dimensional scale from 1 (minimum) to 10 (maximum).

Source: Survey of videoconferencing managers and individual users conducted for this thesis (see Appendix 1 and 2).

Ease of use, audio performance, and video-audio synchronization, as well as conformance to standards (only assessed in corporate survey) are evaluated as

most important selection criteria whereas support for external devices and file formats received, on average, the lowest importance ratings.

Highest satisfaction ratings are given in both cases for ease of use. Also, the technical criteria, video and audio performance and video-audio synchronization, seem to be widely satisfactory although they still reveal a notable gap between importance and current degree of satisfaction. While satisfaction with audio performance almost reaches the level of its importance in the corporate questionnaire, the response by the individual users shows an apparent gap between importance and current satisfaction of audio quality and, therefore, represents the impression most widely shared by experts and users: audio performance is still an annoyance in many video meetings.

A notable concern is also the cost of videoconferencing though its importance is lower rated than that of the technical criteria discussed above. Not surprisingly, conformance to standards and interoperability with other videoconferencing units are the major concerns. Both criteria received rather low average satisfaction ratings and reveal significant gaps between importance and satisfaction. In both questionnaires, support for external devices and file formats is rated lowest as regards satisfaction. However, this criterion also is of lowest importance for respondents with respect to the other criteria being evaluated.

3.6.5 Videoconferencing Applications

The vast majority of videoconferencing business applications today in the U.S. is for intra-company purposes. Most surveys of users reveal that 90% to 95% of all videoconferences are between employees within the same company (Telecommunications Research Group: Svenning, Ruchinskas, and Hart 1993: 73; Kupfer December 28, 1992: 91; Yankee Group: Feldman 9/1993: 45).

Proprietary compression technology and, therefore, limited interoperability, as well as the still apparent preference of in-person atmosphere for meetings external to the company may be the underlying reasons. Especially with respect to customer relations, personal contacts are widely seen as essential. Interestingly, several companies report that clients are increasingly requiring that videoconferencing is part of a project contract (Feldman 9/1993: 46). Technological improvements, as well as increasing acceptance are expected to push an increase of the relative importance of inter-company videoconferences.

M.I.T. Survey: Business Purposes

A trend toward more inter-company video applications is recognizable in the responses to the videoconferencing survey for this thesis (Appendix 1 & 2; corporate survey: 5d; user survey: 3j).

Table 3.6.5-1 shows that the response by videoconferencing managers and individual users does not provide a coherent picture of the composition of videoconferencing applications. While the corporate survey suggests that, on average (simple average of responses, not weighted with respect to specific scope [units, utilization, number of users] of videoconferencing in individual companies), 57% of videoconferencing time are spent for internal meetings, this percentage is 79% according to responses of individual users. Two thirds of respondents to the corporate survey and more than three fourths of those to the user questionnaire state intra-company meetings as primary videoconferencing application in their company and their personal businesses, respectively.

Table 3.6.5-1: Videoconferencing Time Spent for Different Business Purposes

Business Purpose	Corporate Survey	User Survey
<i>Intra-Company</i>	57%	79%
<i>Inter-Company</i>	35%	16%
<i>Customer Service</i>	2%	3%
<i>Conferences / Conventions</i>	2%	0%
<i>Training</i>	3%	1%
<i>Interviewing</i>	1%	1%

Note: Figures indicate relative frequency of total videoconferencing time.

Source: Survey of videoconferencing managers and individual users conducted for this thesis (see Appendix 1 and 2).

On the other hand, the corporate survey sees inter-company meetings at a rather high level of 35% of total videoconferencing time in the companies. Particularly corporations in the computer and electronic industry, and those in the chemical and pharmaceutical sector contributed to this number. Almost all examples reporting inter-company purposes as primary videoconferencing applications were from those industries. While more than 80% of videoconferencing managers reported that their companies use videoconferencing for inter-company meetings, this figure is only 59% for individual user applications. In most cases,

users stated a utilization of 5% to 20% of total videoconferencing time for inter-company purposes -- on average: 16%.

All other business purposes seem to be insignificant for current video applications (0% to 3%). Even training and interviewing identified in other studies as very appropriate for videoconferencing are only of minor importance at present.

Other Classifications

Also, other meeting classifications are applied in the literature. According to Svenning, Ruchinskas, and Hart (1993: 74), videoconferencing is most heavily used for status reviews (19% of respondents reported that as primary usage), staff meetings (15%), project reviews (11%), change review boards (6%), team meetings (5%), and coordination and information exchange (5%). With respect to the relative frequency of videoconferencing use for typical in-person meeting functions, the same survey suggests that informal reviews are the main application (on average, 52% of all time spent for videoconferencing). Important applications are also problem-solving (43%), formal presentations/briefings (28%), and staff meetings (27%). Less frequent use was identified for planning, proposal development, and, not surprisingly, contract negotiations.

In the 1970s and 1980s, job and skills training represented the most popular application for videoconferencing. Meanwhile, according to D/J Brush Associates (*Training* September 1993: 62), management meetings of all levels are the most widely employed form of videoconferencing (78% of survey respondents reported use of videoconferencing for this purpose), followed by product planning (65%), employee information (52%), marketing/sales meetings (37%), and training (28%).

A use of videoconferencing that is gaining increasing popularity is job interviews. Videoconferencing gives employers an effective means of winnowing the field of prospective candidates (first-round interviews) without having to incur the cost of travel. In addition, this technology increases significantly the value of information obtained by conventional telephone interviews through allowing the transmission of facial expressions, eye movement, hand gestures, and other communicational elements that are important in assessing job candidates. A firm where videoconferencing is heavily used for replacing in-person interviews and enhancing the access to potential candidates is Management Resources International (MRI; see section 4.1.3; Apogee 1994: 21; Cummings March 1, 1993: 25).

M.I.T. Survey: User Groups within Companies

The usage of videoconferencing by department and management levels was subject of the survey of videoconferencing managers for this study (Appendix 1; corporate survey: 5a/b).

On basis of the survey response, engineering (using videoconferencing in 75% of companies responding), project management (70%), administration and executives (70%), and research and development (65%) can be identified as the main user groups within the business community. Research and development were stated in 40% of cases as most heavy adopters of videoconferencing in a company. Engineering and administration/executives were named by 20% of companies as most frequent users. Project management is seen in 15% of responses as the most important user group in the company. On the other hand, consulting, customer service, recruiting, and training are only minor users of videoconferencing in the survey sample (see Figure 3.6.5-1).

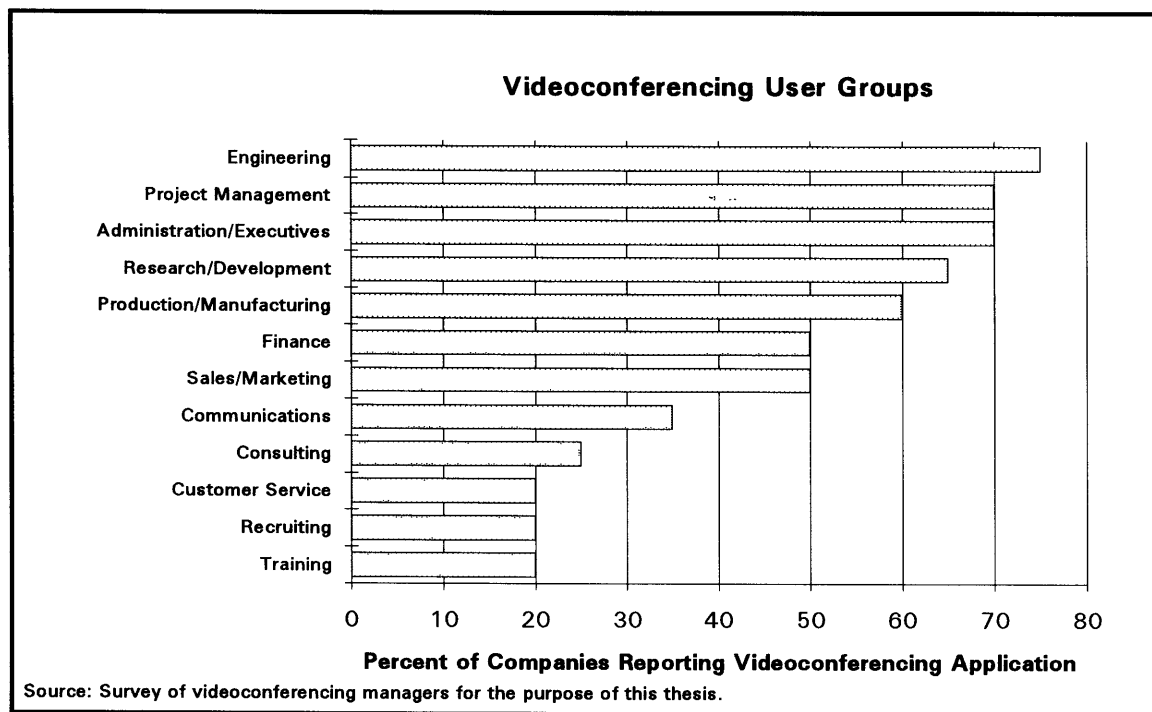


Figure 3.6.5-1: Videoconferencing User Groups

With respect to the vertical organization of a company, all companies responding to the survey reported executives/senior management and middle management as user groups. In 95% of the cases, also lower management was named as a user of videoconferencing. In 62% of companies, middle management

represents the most heavy user group. Executives and senior managers were reported to be the most frequent users in 33% of companies. By averaging the relative frequencies of use reported by each company (simple average, not weighted by scope of videoconferencing adoption by companies), it can be determined that almost half of all applications involve middle management while senior management and lower management each constitute a quarter of all usages (see Table 3.6.5-2).

Table 3.6.5-2: Videoconferencing Adoption by Management Level

Management Level	Most heavy adopter [#]	Average portion of all applications [*]
<i>Executives/Senior Management</i>	33%	27%
<i>Middle Management</i>	62%	47%
<i>Lower Management</i>	5%	25%
<i>Others</i>	-	1%

[#]: Percentage of companies reporting management level as most heavy adopter of videoconferencing.

^{*}: Percentage of all videoconferencing applications reported; averaged over all responses (simple average; no weighting by number of systems, sites equipped, employees using videoconferencing, or daily utilization).

Source: Survey of videoconferencing managers conducted for this thesis (see Appendix 1).

This indicates that videoconferencing is meanwhile established in all management levels. Whereas executives and senior managers were initially the main adopters of this technology, videoconferencing has now penetrated into middle and lower management. Middle management is today the main user group. With respect to this fact and the need of many businesses to rationalize their organization particularly in these management levels, researchers and analysts suggest that videoconferencing helps companies to streamline management.

Other Usage Characteristics

M.I.T. Survey: Percentage of Videoconferences within the U.S.

On basis of the survey response (Appendix 1; corporate survey: 5c), a relative portion of 78% of all videoconferences conducted by the companies responding can be derived for applications within the U.S. Again, this figure is based on a simple, non-weighted average. The range of videoconferences held domestically depends on industry, businesses, company size, and geographical scope of business relations and varies between 15% and 100% in the sample. Almost 60% reported more than

85% of all company's video meetings are held in the U.S. In 36% of the cases, U.S. domestic applications constitute 95% to 100%.

Annual Videoconferencing Expenses

According to D/J Brush Associates (*Training* September 1993: 62), the median budget of companies for video projects (videoconferencing plus corporate video productions) increased by 42% from 1988 to 1992, representing an average annual growth of around 9%. The median annual video budget in 1992 was, according to this source, \$409,000.

The company-wide expenses on videoconferencing in 1993 were also asked in the corporate survey for this thesis (Appendix 1; corporate survey: 3f). The mean of \$500,000 per year derived from the received responses fits into the growth trend identified by D/J Brush Associates.

Other Applications of Videoconferencing

Besides the application of videoconferencing for various business meeting purposes, some other areas of significant videoconferencing use deserve individual mention (Mokhtarian 3/1990: 234-235; Bergman October 20, 1993: 46-48):

- ☒ Tele-education: Distance learning; using videoconferencing or other means of modern teleconferencing to transmit classroom instructions to one or more remote locations; this application is quite common; according to industry experts, 80% of all teleconferences held at the end of the 1980s were for educational and training purposes.
- ☒ Telemedicine: Telemedicine enables 2-way interactive video consultation and the transmission of digital images, such as x-rays, electrocardiograms, or heart sonograms, to other sites in order to receive diagnosis and treatment regimen; telemedicine provides improved medical care to communities that do not have medical experts and specialty services; health professionals in rural areas are able to consult specialists in metropolitan areas.
- ☒ Telejustice: Routine functions, such as depositions and arraignments, can be handled through videoconferencing links between

courthouse and prison; furthermore, witnesses from distant locations can easily and cost-effectively be involved in a trial.

While the latter two forms of teleconferencing primarily enable communication links not possible before and may have only a marginal potential to impact air travel, tele-education as a very common videoconferencing application does compete in many areas for the same demand as air travel, especially with respect to training programs of business corporations and government organizations.

3.6.6 Videoconferencing Policies

Although some surveys of videoconferencing users (Business & Commercial Aviation January 1994: 34) suggest that the majority of companies using in-house videoconferencing facilities do not have formal procedures to decide when a company employee has to use videoconferencing instead of traveling, the literature reveals an increasing number of examples where corporations do pursue such videoconferencing-travel policies.

In most cases, videoconferencing is put in charge of the telecommunications or information systems department. However, often travel and meeting managers of a company play a decisive role, and are involved in planning for corporate videoconferencing systems in order to identify areas where the use would be beneficial -- examples: Tandem Computers Inc., Amoco Corp., Monsanto Corp., and Unisys Corp. (Gerety January 27, 1992: A7). Corporate travel managers are integrating appropriate wording into the corporate travel policies and educate travelers on videoconferencing uses so they can make informed choices.

A fairly clear travel policy on using videoconferencing has been established by Unisys Corp. (Gerety January 27, 1992: A8). It focuses on in-house meetings and says that employees do not to travel for internal meetings unless accessibility to systems cannot be provided or physical presence is essential for the business purpose.

An interesting example for tight videoconferencing-travel policies is also Swiss Bank in New York City (Arvai 1994: 5). It placed its worldwide 75 video units directly under control of the travel department. Consequently, each business travel approval now includes a non-traditional alternative: videoconferencing.

Most companies using videoconferencing have less stringent, or no videoconferencing policies at present. In such cases, managers are often asked to assess each business trip in light of its business importance and appropriateness to be substituted by videoconferencing. However, the final decision as regards the meeting medium remains in the hands of the individual employee.

3.6.7 Plans for the Future

M.I.T. Survey

In the survey for this thesis, videoconferencing managers were asked about their current plans regarding future expansion of videoconferencing in their company (Appendix 1; corporate survey: 4a/b). A considerable growth of the company's videoconferencing budget in the order of 10% to 25% in the next two to three years is expected by 38% of respondents. An even higher growth is expected by 43% of videoconferencing managers. Projections of a more than doubling of today's budget for videoconferencing in the next two to three years are made by 10% of companies. A similar portion, on the other hand, expects no real change at all.

Rollabout systems are evaluated by 86% of the videoconferencing managers as the segment future investments will be most probably made in. For 55% of respondents, major investment is also most probable for the desktop video area (note: multiple responses have been made). Another 27% see an investment in LAN-based video applications as most probable while boardroom systems are assessed as least interesting area for future expansion -- reflecting general market evaluations. Though this type of videoconferencing is today still subject of prime use (see section 3.6.3), only 18% of companies expect major investments in boardroom facilities in the near future.

Study of Market Potential for Desktop Video

Personal Technology Research (PTR; 1993) conducted an end-user study (75 companies of "Fortune 500" group) for evaluating the market potential and application needs for desktop video. More than half of the respondents (52%) stated that their companies were actively assessing desktop videoconferencing at the time of the study (March 1993). However, only 42% stated that they felt that a system they purchased today would meet future needs.

More than 50% of companies surveyed were still undecided about the time when an initial investment in desktop videoconferencing would be probable --

although 70% of those said they anticipate a need within the next five years. One out of five respondents stated to plan to adopt to desktop video in the following 12 months. Another 13% evaluated the time horizon for such an acquisition within one to two years. The residual 14% saw a need for this technology not before mid-1995.

As a user group within the company that had identified the largest need for desktop video, executives and management (33% of all potential users) were determined. As next most important adopters to desktop video, engineering (24%), marketing/sales (14%), training (7%), and production (5%) were seen.

3.7 Impacts on Business Communications and Corporate Structure

Often, a company implements videoconferencing to address a specific business need, such as travel cost reduction for a specific project, but then finds that videoconferencing has brought about unexpected changes in the organizational structure and communications. In companies that have made a broad range of communication options available to their employees, changes in the way how people communicate and collaborate are becoming apparent (Svenning 1994).

The impact of modern telecommunications, especially of videoconferencing, on business communication behavior and outcome, and its effectiveness as a substitute for natural face-to-face communication associated with physical presence, as well as its effect on corporate and organizational structures are addressed in this section.

3.7.1 Communication Behavior and Effectiveness

Natural face-to-face communication brings individuals together to share a variety of information in the same location and at the same time. Each person can use all his or her senses to size up the other person (Economic Research Centre 1983: 30).

It is often believed that using a technical communication medium, such as videoconferencing, leads to a loss of social and psychological significance of communication. It is thus associated with a lower effectiveness since such an interface only allows some of the dimensions in the communication and interaction to be transmitted. However, the following discussion of research performed on the communication behavior and effectiveness of videoconferencing shows that much

of the opinion that videoconferencing lacks in its effectiveness to transmit the keys essential to business communication is more or less prejudicial.

Most experts in the field of communications agree that the corner stone of the research of this issue is the identification of communication behaviors, attitudes, preferences, and needs that can be met effectively through videoconferencing.

A comprehensive study focused on these aspects has recently been conducted by Svenning, Ruchinskas, and Hart (1993). In this study, it was examined how videoconferencing is used in a business environment, how videoconferencing communication compares with natural face-to-face communication, and what effect videoconferencing has on meeting behaviors and outcomes. The results of the study confirm earlier findings that users assess video meetings as comparing favorably with face-to-face meetings for a wide variety of purposes. The perceived benefits of videoconferencing greatly outweigh limitations, such as higher formality or less spontaneity (Svenning et al. 1993: 71). Contrary to earlier studies where these findings were derived from laboratory research or demonstrations, the study of Svenning, Ruchinskas, and Hart has been conducted in a "real" environment among experienced videoconferencing users in a large aerospace company organized into major functional units. Employees of these units work in multiple locations and are involved in interorganizational projects.

Effectiveness of Videoconferencing Compared with Face-to-Face Meetings:

The effectiveness of videoconferencing for business meeting purposes has been measured by Svenning et al. (1993: 74) through user evaluations of productivity, satisfaction with results, and the degree of consensus achieved in making decisions via videoconferencing.

The results are convincing (see Figure 3.7.1-1; Svenning et al. 1993: 74/75). Only 12% of respondents to the survey evaluated videoconferencing as less productive than corresponding in-person meetings. Researchers and users recognize that this perceived productivity might be a function of time constraints imposed by the need to get the job done within the time slot the videoconferencing facility is booked. Therefore, videoconferences are usually shorter than comparable face-to-face meetings. However, also the greater degree of formality that participants experience in a video meeting, as well as curtailment of disruptive side conversation are often viewed as contributors to an increased productivity.

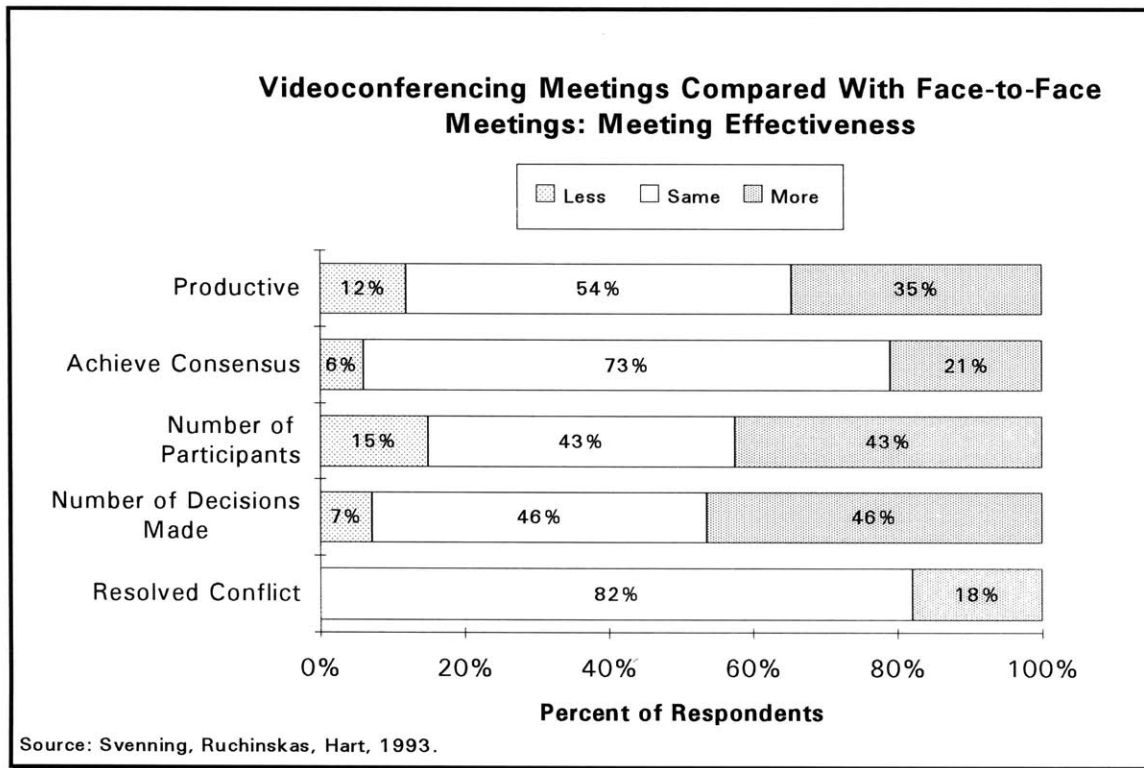


Figure 3.7.1-1: Videoconferencing Meetings Compared With Face-to-Face Meetings: Meeting Effectiveness

Group effectiveness through video is also enhanced by the higher level of consensus achieved and the larger number of decisions made. In the survey by Svenning et al., both aspects were evaluated as highly favorably compared with in-person experience. Videoconferencing, furthermore, was assessed to equally or less likely end with conflicts and issues unresolved. A benefit often claimed by users and researchers, and confirmed in the study by Svenning, Ruchinskas, and Hart (1993), is the involvement of more people in a videoconference compared with a corresponding natural face-to-face meeting. Including more people and, therefore, a higher diversity of perspectives in the decision-making process is seen to be an additional productivity enhancement.

Impacts of Videoconferencing on Meeting Behavior:

The research by Svenning et al. (1993: 75-77) also confirms most earlier findings regarding meeting behavior in videoconferences. Video meetings are evaluated to be more task oriented, more structured, and also more formal and less spontaneous. The latter characteristic is often seen as a consequence of less give and take among conferees (see Figure 3.7.1-2).

Most users claimed that videoconferencing has almost no effect on the opportunity to express his or her opinion in a business meeting. Confirming earlier studies, the research of Svenning et al., in addition, suggests that video meetings appear to require for slightly more structure and direction. This characteristic is seen as cause for higher perceived formality and sterility.

Svenning (1994: 6) also provides evidence that, at the same time, participants are usually better prepared for videoconferences than face-to-face meetings, resulting in more discussion and more decisions being made, in a more timely manner.

Svenning, Ruchinskas, and Hart (1993: 76/77) also suggest that videoconferencing has additional effects on individual meeting behaviors that upgrade the quality of communication (see Figure 3.7.1-3).

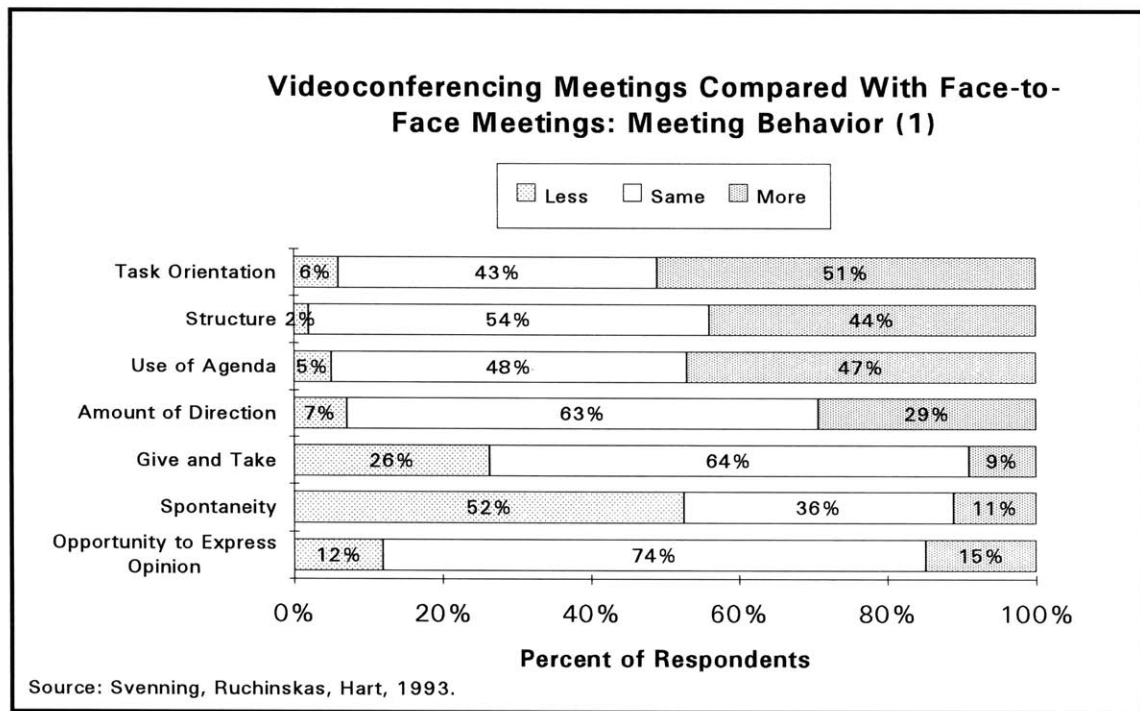


Figure 3.7.1-2: Videoconferencing Meetings Compared With Face-to-Face Meetings: Meeting Behavior (1)

People usually reflect longer before contributing to the discussion, feel more responsible for the meeting productivity, stick to the point more than in in-person meetings, and feel that there is less maneuvering and jockeying for positions in a video meeting. Furthermore, debriefing after the meeting is evaluated as being usually more important than in a face-to-face meeting.

Videoconferencing also appears to tolerate less unproductive communication behavior, such as disruptive side conversations or sub-group caucuses. Also, the interrupting of other speakers is seen as being more difficult and, therefore, occurs less often. In this context, one of the common technical deficiencies of videoconferencing, the transmission delay, might be a significant cause of this behavior (Ramirez February 5, 1992: D9).

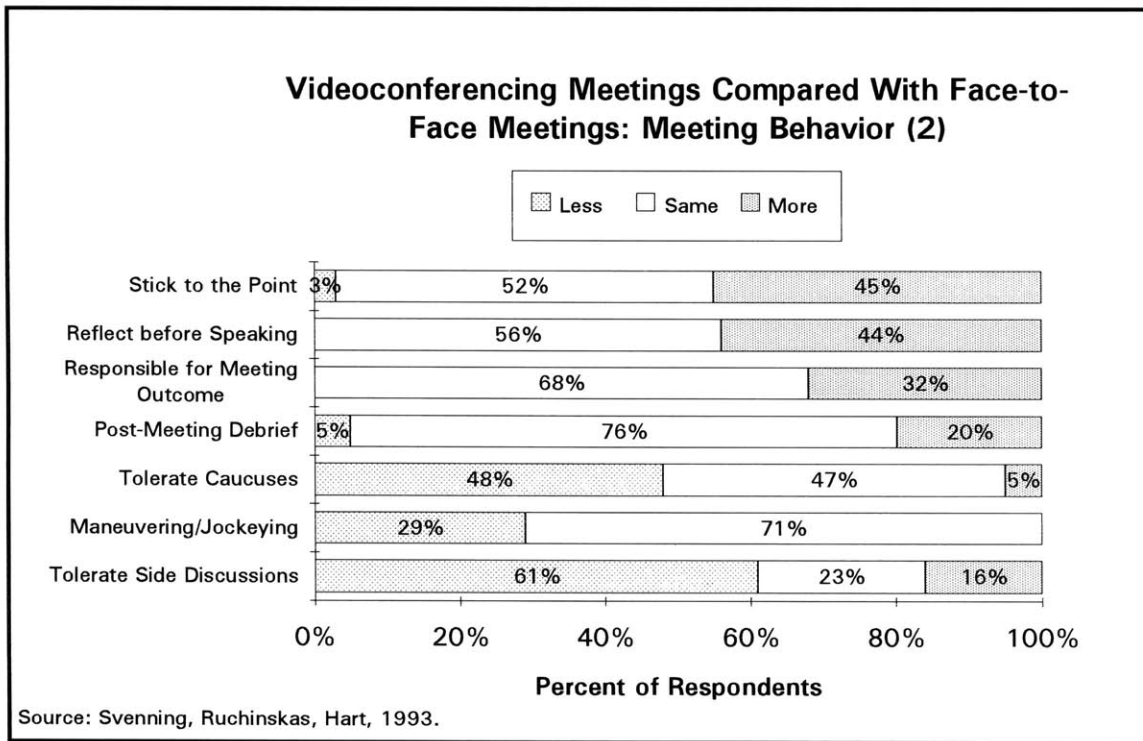


Figure 3.7.1-3: Videoconferencing Meetings Compared With Face-to-Face Meetings: Meeting Behavior (2)

Finally, the research of Svenning, Ruchinskas, and Hart (1993: 77-78) concludes that the use of videoconferencing has a very small impact on the use of other telecommunication media. The only medium appearing to suffer a significant decline is dedicated room audioconferencing since it lacks interaction "richness" compared with videoconferencing.

Researchers see a concentration of productive communication and meeting behavior (being well prepared, using an agenda, reflecting before speaking, assuming more responsibility for meeting efficiency, etc.) and a curtailment of unproductive communication behavior (interrupting speakers, engaging in side conversations, or caucusing) as the most evident results of using videoconferencing (Svenning 1994). The greater task focus in video meetings combined with more

effective and efficient meeting behavior results in productive meetings, which are slightly less interactive than in-person meetings (Svenning et al. 1993: 79).

However, since existing research also suggests that videoconferencing participants feel more time pressure, researchers still argue whether the perceived differences between video and natural face-to-face meetings discussed above are a direct result of the videoconferencing medium, or are more a consequence of the time constraint of working within scheduled time slots (Svenning et al. 1993: 77).

It is interesting to note that researchers suggest videoconferencing is most useful and its benefits are most likely to be achieved if the participants know each other, and if their communication is based on common recognition, background, and experience.

Assessment of Videoconferencing Process and Outcome:

In the survey of this thesis, users of videoconferencing assessed the effectiveness of this technology as regards different activities that take place in natural face-to-face communication (see Appendix 2; question 6d). The selection of activities to be evaluated was based on a teleconferencing survey conducted in the United Kingdom by the Communications Study Group (CSG) in the early 1980s and aimed to determine user satisfaction with teleconferencing technology (Economic Research Centre 1983: 33-34).

Characteristics of communication process and meeting outcome were rated in our survey by using a scale from 1 (not possible in videoconferences) to 10 (completely the same in a video meeting as in a natural meeting).

The results regarding **communication processes** widely confirm findings of the CSG study (Economic Research Centre 1983: 33-34) and the conclusions of the studies discussed earlier in this section. In most cases, videoconferencing is fairly satisfactory and almost as effective as in-person communication (see Figure 3.7.1-4).

The degree of effectiveness depends strongly on the complexity of communication involved. Activities of least complexity, such as giving and receiving information (average rating of 8.2; 60% of responses greater or equal 9) and asking questions (average rating of 8.0), are most satisfactory in videoconferences and almost comparable with face-to-face communication. Furthermore, videoconferencing does not seem to constrain the expression and exchange of opinions

(average rating of 7.9; 53% of ratings equal 9) or the generation of ideas (7.8; 47% greater or equal 9).

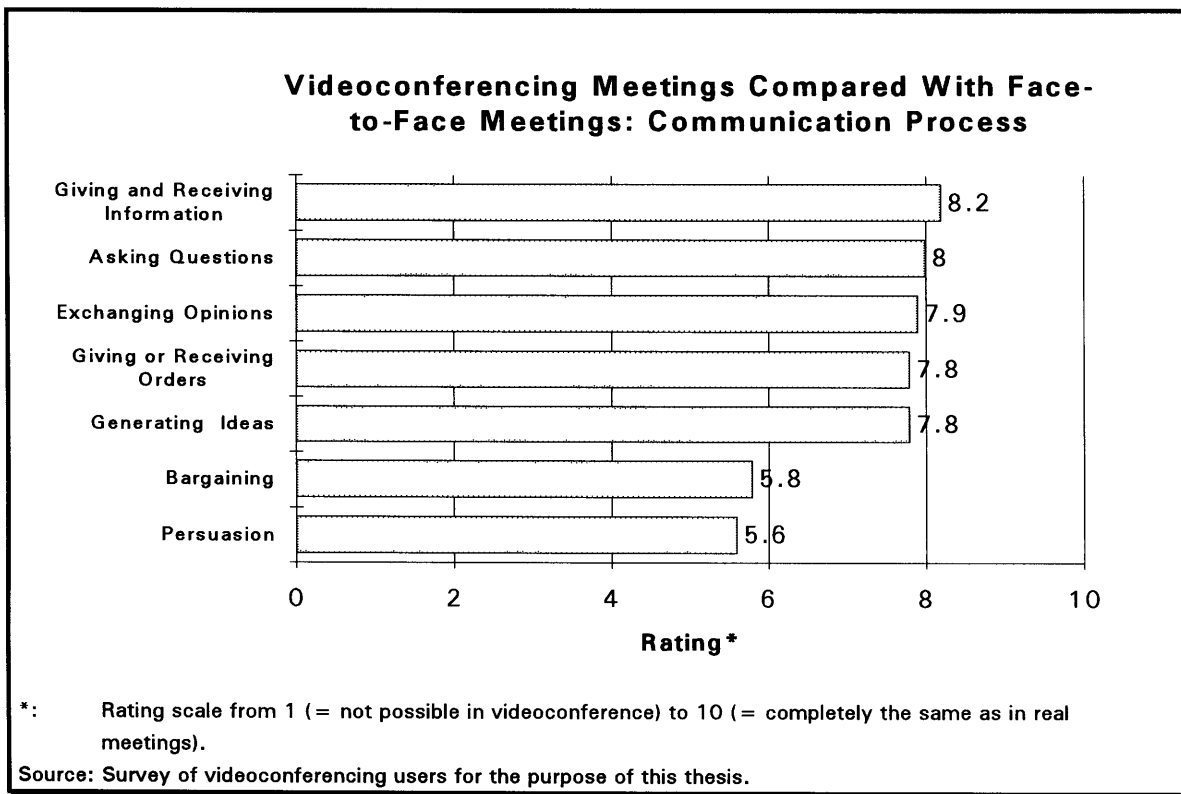


Figure 3.7.1-4: Videoconferencing Meetings Compared With Face-to-Face Meetings: Communication Process

On the other hand, more complex communication processes, such as persuading and bargaining, are evaluated as significantly less effective in videoconferences compared with face-to-face communication.

With respect to the **outcome of videoconferencing meetings** (see Figure 3.7.1-5), the capability to solve problems (average rating of 7.9; 41% of ratings are 9 or 10) and to make decisions (7.9; 47% of ratings 9) is widely seen as highly comparable to the in-person atmosphere. On the other hand, the effectiveness of videoconferencing to retain business relationships is significantly lower rated (average of 6.4; 18% of rating equal or below 3), implying the view that personal meetings are inevitable in order to maintain successful business relations.

More complex meeting characteristics, such as resolving of disagreement (average rating of 6.0) and resolving of conflicts (5.8) are evaluated as only partially comparable with natural face-to-face meetings. In both cases, 12% of respondents even assess the aspect as not possible in videoconferences (rating of 1). This result

is not in conformity to findings of Svenning, Ruchinskas, and Hart (1993: 74/75; see Figure 3.7.1-1) discussed earlier in the section, suggesting that videoconferences equally or less likely end with conflicts and issues unresolved.

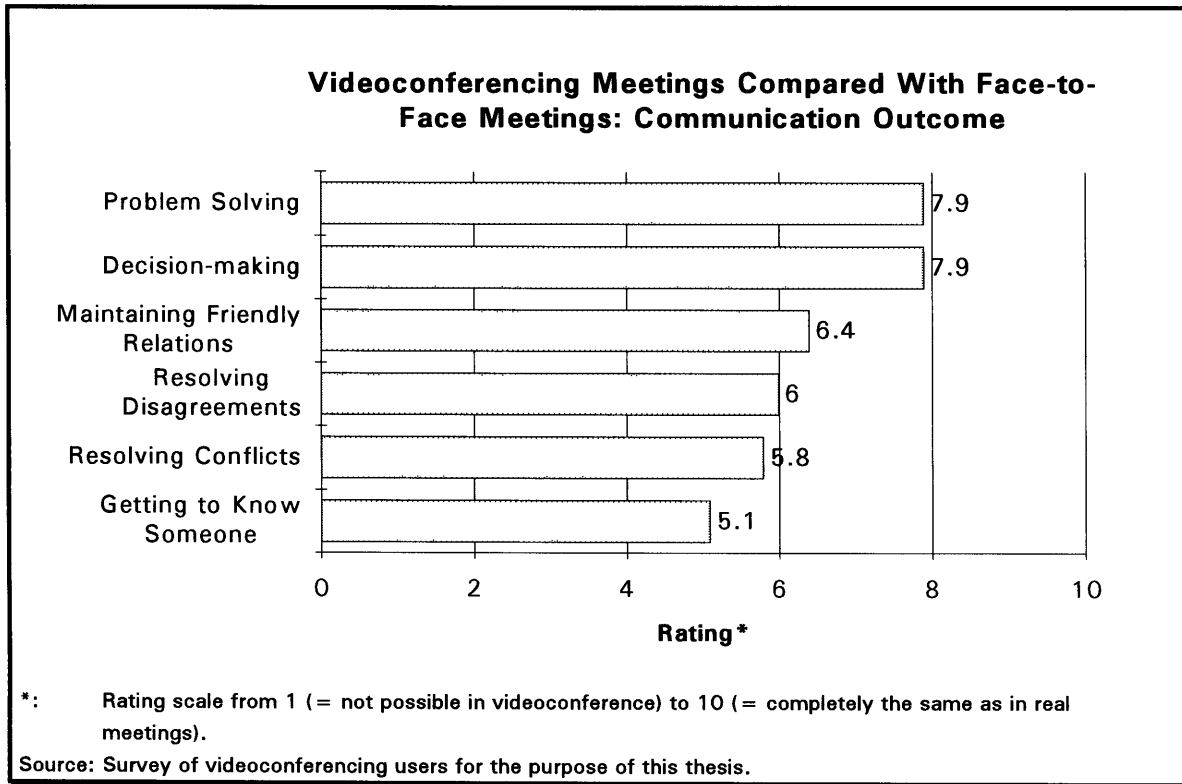


Figure 3.7.1-5: Videoconferencing Meetings Compared With Face-to-Face Meetings: Communication Outcome

The lowest satisfaction compared with in-person communication can be seen with respect to the capability to make first contacts through videoconferencing (average rating of 5.1; 65% of responses equal or below 5). This confirms the evaluation of most researchers that benefits of videoconferencing are most probably achievable if people interacting via video know each other.

Negative Communication Characteristics in Video Meetings:

After discussing research supporting that videoconferencing is widely comparable with natural face-to-face communication and even advantageous, some negative characteristics claimed by users and researchers should be addressed.

Although videoconferencing is able to serve as a forum for completing tasks and is associated with apparent result-orientation and productivity, it does not sufficiently address group affiliation needs, which are widely assessed as a distinct

purpose served by corporate meetings (Human Interface Group; LaPlante September 13, 1993: 117/118).

Another problem recognized is the tendency of teleconferencing participants to be much less inhibited and often less courteous during meetings, which may lead to misunderstandings that can fester due to a lack of immediate confrontation. A study by the Business School of the University of Michigan (LaPlante September 13, 1993: 118) suggests that people may tend to be more hostile and aggressive when using electronic communication media.

3.7.2 Impact on Corporate Structure and Spatial Characteristics

Modern telecommunications and particularly videoconferencing in combination with other interactive tools have had various and extensive impacts on the organizational and spatial structure of corporations.

Improved telecommunications have lessened the importance of business locational decision and promote dispersing and decentralizing operations. Geographically dispersed locations can be much more effectively integrated into a company's business activities, and a re-allocation of tasks among dispersed units can be more efficiently done.

Collaboration and team working among sections of a company by using enhanced, highly interactive telecommunications technology is vividly described by David Whitwam, CEO of the Whirlpool Corporation, with the following statement (as quoted in Svenning 1994): "People don't need to sit next to each other anymore to work together on the same project. In fact, it's no longer appropriate or effective to design organizations that way. Instead, global competitors will increasingly make use of "virtual teams", as we and others are already doing."

Companies competing and cooperating in an increasingly globalized marketplace are pushed and pulled into more and more "telecollaboration" (Svenning 1994). The availability of sophisticated telecommunication systems has notably contributed to the shift of thinking about how to organize work from static to more fluid and flexible organizations, from building-based to virtual cooperation, and from hierarchical to flat, spiderweb, cluster, or inverted models of organization (Svenning 1994). Interactive telecommunications, such as videoconferencing, allow the down-sizing, outsourcing, reengineering, and shape-shifting of organizations into more efficient, more dynamic, and more productive units.

With respect to the impact of these organizational and spatial restructuring processes on travel behavior, it should be considered that many of these changes are occurring more often on a regional and urban basis and, therefore, affect issues of telecommuting. However, with increasing geographical scope of these organizational developments, also inter-city travel and, consequently, air travel can be expected to be affected.

Dispersing of offices within enterprises into smaller units will stimulate the growth of small centers and the development of business parks around them. In addition, videoconferencing and other enhanced multimedia technologies enable business to evolve among minor and peripheral centers without the absolute need for physical travel. This is possible to relax the pressure on existing urban business hubs and encourage even smaller centers to promote their own business communities. These changes are highly probable to impact air travel by producing new travel patterns, primarily for the commuter and regional air traffic (Brebner 1994: 2,8).

3.8 Overall Benefits and Limitations of Videoconferencing

After addressing the impact of videoconferencing on business communication behavior and effectiveness and stressing the enhancements and limitations of communication via videoconferencing, the general benefits and disadvantages of this telecommunications technology are discussed in this section.

3.8.1 Benefits of Videoconferencing

As stated earlier (see particularly section 3.6.2), videoconferencing has evolved from a tactical tool employed for mere travel substitution purposes to a strategic instrument offering benefits of a much larger scale for a company's business. The accomplishment of such strategic benefits by a company is often a function of time. Through experience, corporations recognize adoption patterns for videoconferencing that bring about beneficial changes in business communications and organizational structure, leading to enhancements in productivity and competitiveness. In most cases, these benefits are not addressed in the formal investment justification.

Although travel cost and time savings are often not the prime factors for today's videoconferencing adoption, and companies justifying the investment with travel replacement soon discover other more desirable gains, travel substitution remains a

main benefit. The aspect of travel replacement -- or stimulation -- is not addressed in this section's discussion. It is the focal point of the analysis throughout section 4.

In the following, the strategic benefits observed by users and supported in research works are categorized into benefits for organizational structure and locational decisions, enhanced business communications, gains in productivity, improved competitiveness, and other beneficial effects (see Table 3.8.1-1).

Organization and Location

Organizational and locational aspects associated with videoconferencing and other multimedia tools were addressed in the previous section 3.7.2. Flexibility and freedom in organizational and locational choices and improved teamwork among geographically dispersed sites are seen as prime benefits.

Business Communications

Enhanced business communication behavior and effectiveness were the subject of the previous discussion in section 3.7.1. Although certain face-to-face meetings remain inevitable, such cases become more a matter of choice (Johansen, Bullen 1983: 17). Videoconferencing provides new communication opportunities, the so-called "impossible" meeting. For example, executives may wish they could gather their regional managers together in one place for a monthly meeting. This may be economically impossible or cause too much interruption of their work without videoconferencing (Daly 1994: 4). The technology increases communication flexibility and allows more frequent face-to-face gatherings.

Often stressed by researchers as an important benefit is the possibility to get more people involved in a meeting. The phenomenon of having access to the "right people at right time" by using videoconferencing is supported by the study of experienced videoconferencing users in two Navy Research and Development centers by the Telecommunications Research Group (TRG; Svenning 1994).

Table 3.8.1-1: Strategic Benefits of Videoconferencing

Organizational & Locational Benefits
<ul style="list-style-type: none"> ➤ Flexibility and freedom in organizational structure and locational decisions. ➤ Less non-productive duplication between geographically dispersed sites. ➤ Improved teamwork and collaboration over distance (internal and external).
Enhanced Communications
<ul style="list-style-type: none"> ➤ Certain inevitable face-to-face meetings become more a matter of choice (travel shifting). ➤ New communication opportunities are provided that have not been practical before → the impossible meeting; serving latent demand for communications that do not justify traveling. ➤ Increased degree of managerial choice as regards frequency of communication (increased communication flexibility). ➤ Maintaining business relations without having to travel for each face-to-face meeting. ➤ Better organized and structured meetings. ➤ Larger participation; opportunity to get more experts involved in a meeting → optimizing the use of human resources ("right people at right time"). ➤ No time wasted for social chitchat; shorter meetings than in case of in-person gatherings. ➤ Increased communication effectiveness. ➤ Improved planning for in-person meetings and possibility of rapid follow-up meetings.
Productivity Gains
<ul style="list-style-type: none"> ➤ Increased employee productivity and efficiency; savings in unproductive time. ➤ Accelerated and spontaneous decision-making; urgent meetings at short notice. ➤ Shorter cycle times (product development). ➤ More focused sales efforts. ➤ Streamlining of workforce.
Improved Competitiveness
<ul style="list-style-type: none"> ➤ Improved customer service/contact. ➤ Faster times-to-market. ➤ Productivity and efficiency gains. ➤ Increased profit margins due to rationalization and cost cutting and to improved ability to generate revenue. ➤ Intensifying of existing business relations and provision of new business opportunities on wider geographical scale. ➤ Opportunity for small and mid-size businesses to participate in global marketplace.
Other Benefits
<ul style="list-style-type: none"> ➤ Independence of Gulf War scenarios; reduction of travel risk. ➤ Improved quality of life through reduction of travel stress and other related symptoms. ➤ Improved training. ➤ Substitution for shipment of materials and documents.

"Right people" can range from key decision makers to technical expertise to junior level people. Videoconferencing may make the actual location of these "right people" almost irrelevant. The organization has more flexibility in optimizing the use of its human resources. The "right people" can attend meetings wherever they happen to be (Svenning 1994).

Equally important to improved access to experts is the time aspect. "Right time" embraces timing and timeliness. Timing refers to synchronized coordination both within and between members and with other relevant sets of events and activities. Timeliness means that meetings happen when they need to happen. Timely decisions through videoconferencing enable work groups also to make faster decisions. The study of Svenning (1994) suggests that to have meetings with the "right people" making the "right decisions" at the "right time" ultimately improves the quality of the product. In addition, everyone is more comfortable with the decision when all the important people are involved and have continuously been informed about the problem in the period before the decision.

Besides these benefits and those discussed in section 3.7.1, videoconferencing enhances business communications by allowing improved planning for subsequent in-person meetings or rapid follow-up meetings not economically justified without video technology.

Productivity

Advances in the organizational structure of a company and in teamwork over distance, as well as in overall communications contribute to significant advances in productivity of employees and work groups. Furthermore, savings in unproductive time associated with travel are a significant productivity enhancer. Gains in productivity can further derive from shorter product development times due to faster and more spontaneous decision-making.

Also, more focused sales efforts through videoconferencing are seen as contributors to increased efficiency. A more productive sales force may be able to handle more customers and accomplish more sales in the same time as one fully relying on travel for face-to-face meeting purposes.

Furthermore, productivity gains can help a company to streamline its organization and rationalize its workforce. Therefore, making people more productive through videoconferencing may lead to reduced costs and, at the same

time, to an improved ability of a company to generate revenue (KJH Communications 1994: 4-4 - 4-6).

Competitiveness

As result of the benefits stated above with respect to organizational patterns, business communications, and employee and group productivity, videoconferencing is an important competitive tool. Faster times-to-market and improved customer services through teleconferencing improve the competitive edge of a company. Productivity and efficiency gains allow cost cutting and provide an enhanced revenue potential, which finally lead to increased profit margins.

Videoconferencing allows an intensifying of existing business relations and provides, at the same time, new business opportunities of wider geographical scope. Through videoconferencing and other interactive tele-media, small and medium-size businesses are capable to compete in the global marketplace.

Other Benefits

Videoconferencing offers independence of Gulf War scenarios associated with extensive negative impacts on international business. It further improves the quality of (business) life through reducing travel stress. Jet-lagged travelers have no longer to represent the opinions and concepts of a company. Also, improved training of employees is often named as a notable benefit of videoconferencing usage. And, videoconferencing may even substitute for shipping materials and documents. Instead of using overnight courier services, merchandise, mechanical parts, or designs can be shown to people in distant sites through videoconferencing (KJH Communications 1994: 4-3).

Time, Timing, and Speed

Time, timing, and speed, and their role in promoting productivity and competitiveness of a company have already been identified above as important strategic opportunities provided by videoconferencing. According to Svenning (1994), time and timing of decisions are prime "competitors" for any company in today's marketplace. And, since success depends on the creation of a series of temporary advantages, a corporation's ability to move quickly from one advantage to the next is crucial for its competitiveness. Acceleration of decision-making processes via videoconferencing allows a company to maneuver and disrupt the

status quo in competition, erodes the advantage of competitors, and creates new advantages before competitors are able to match earlier moves.

In the study of experienced videoconferencing users by the Telecommunications Research Group (Svenning 1994), 75% of respondents to the survey reported that videoconferencing enabled them to complete tasks and projects faster.

M.I.T. Survey

Benefits of videoconferencing were also subject of the survey of videoconferencing managers and individual users in companies conducted for the purpose of this thesis (Appendix 1 & 2; corporate survey: 8a; user survey: 6a). Different potential benefits of videoconferencing were assessed with respect to their significance for the company's and personal business, respectively, by using a non-dimensional rating scale from 1 ("I strongly disagree that the benefit is significant") to 10 ("I strongly agree with the significance of this benefit"). Figure 3.8.1-1 illustrates the average ratings given by videoconferencing managers and users for the different benefits.

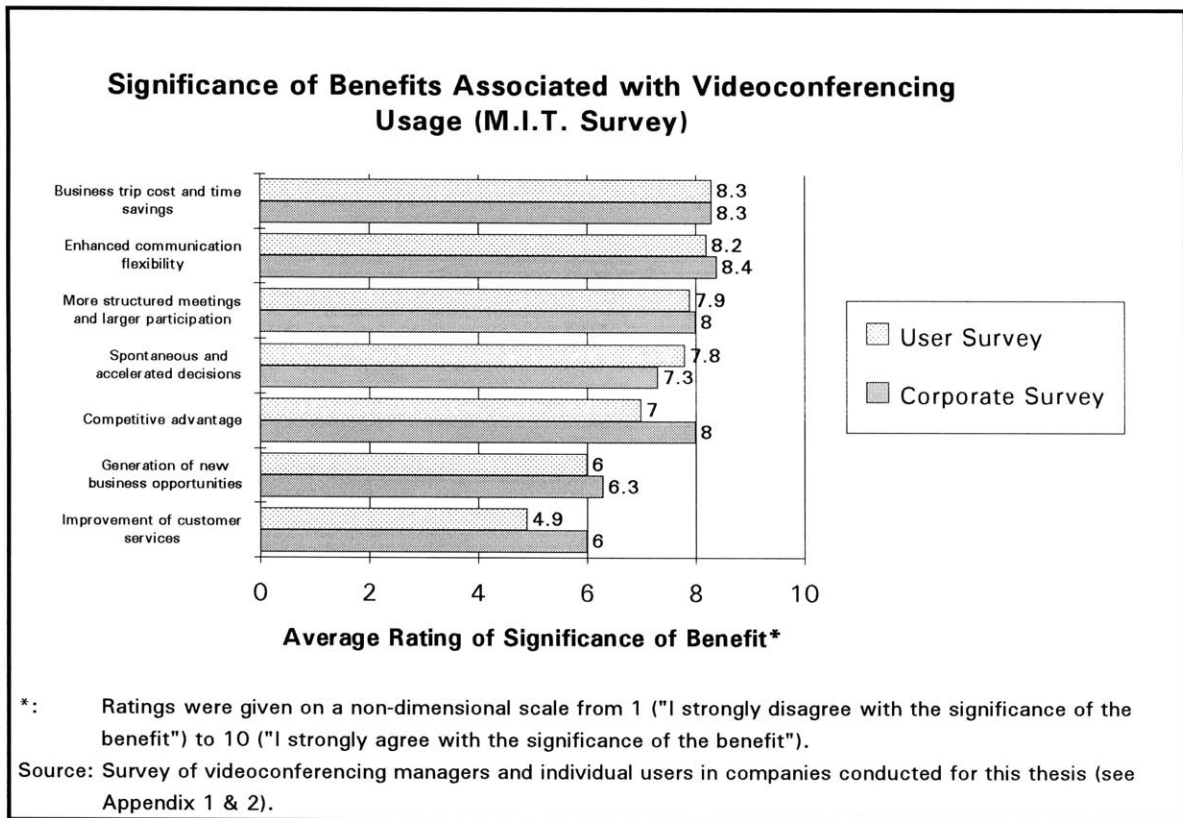


Figure 3.8.1-1: Significance of Benefits Associated with Videoconferencing (M.I.T. Survey)

Overall, the assessments (average ratings) in the corporate and user survey show a wide conformity. Only slight deviations in evaluations of the degree of particular benefits are apparent while the general tendency reflects agreement about the relative significance of the listed benefits.

The survey results confirm the significance of travel cost and time savings for a company. Travel substitution and enhanced communication flexibility are seen as the most significant benefits of videoconferencing. More than half of the respondents in both questionnaires rated the importance of each aspect with 9 or 10.

The benefit of more structured meetings and larger participation received the third highest rating in both questionnaires. Slightly different are the levels of agreement about the significance of spontaneous and accelerated decision-making enabled through videoconferencing. While the users see this benefit, on average, almost at the same level as the latter benefit, the videoconferencing managers evaluate videoconferencing as improved decision-making tool as less significant. On the other hand, the corporate survey suggests a notably higher importance of videoconferencing as a competitive tool than the user questionnaire.

The responses to both surveys reveal that videoconferencing is not seen as an instrument to considerably improve customer services. In both questionnaires, this potential benefit received the lowest rating. More than one fourth of the user respondents rated it only with 1 or 2. The results emphasize that videoconferencing still lacks acceptance as medium to retain customer relations.

Also, the generation of new business opportunities, a benefit often supported by researchers with respect to the theory of stimulation of new travel needs by videoconferencing (see 4.1.2.2), is widely not seen as significant, particularly in relative terms to the other benefits.

Significance of Benefits as Function of Experience with Videoconferencing

Some of the existing research suggests that the perception and weighting of benefits from the use of videoconferencing by companies depend on the level of experience with the technology. In the following, the received assessments of the significance of potential benefits by the videoconferencing managers are analyzed with respect to the time companies have already been using this technology.

According to several analysts and researchers, most early adopters of videoconferencing evaluated travel savings as key benefit of this telecommunication

technology. However, with increasing experience of use, most companies would have developed usage patterns making other benefits, mainly of more strategic nature than mere travel substitution, apparent.

Table 3.8.1-2 shows the average ratings of the significance of travel substitution, accelerated and spontaneous decision-making, increased competitiveness, and generation of new business opportunities by the videoconferencing managers as function of the level of experience of the corresponding companies with videoconferencing. The overall sample size of 23 companies limits the number of responses received per experience level. Therefore, it must be considered that the trends interpreted subsequently are empirically weakly founded.

Table 3.8.1-2: Rating of Significance of Benefits as Function of Level of Experience

Level of Experience	Travel Cost & Time Savings	Faster Decision-making	Competitive Tool	New Business Opportunities
<i>< 1 Year</i>	7.3	7.5	6.8	8.0
<i>1 - 2 Years</i>	8.0	6.3	7.7	4.3
<i>2 - 3 Years</i>	7.2	6.3	8.6	7.2
<i>3 - 4 Years</i>	9.5	7.5	6.0	5.5
<i>4 - 5 Years</i>	10.0	8.0	8.3	6.0
<i>> 5 Years</i>	9.0	8.6	9.2	5.8

Note: The figures enclosed in the table are averages of the received responses.

Source: Survey of videoconferencing managers conducted for this thesis (see Appendix 1).

Travel Cost and Time Savings

With increasing experience, travel savings received, on average, higher significance ratings. This trend does not support the theory that with increased experience, travel savings accomplished by videoconferencing diminish in their importance for a company. Corporations having adopted to this technology earliest are assessing travel substitution as a greater benefit than most recent adopters.

Spontaneous and Accelerated Decision-making

A similar trend is also apparent with respect to spontaneity and speed of decision-making via videoconferencing. Though the average rating for "< 1 year" does not match the qualitative correlation, an increase in the perceived significance of this more strategic benefit with growing experience is recognizable. This result confirms most observations and suggestions made in prior research.

Competitive Tool and Generation of New Business Relations

Less significant correlations have been received for the two other benefits, enhanced competitiveness and generation of new business opportunities. However, the results suggest an underlying trend of increased importance of videoconferencing as competitive tool with higher level of experience. Also this result would support a hypothesis widely shared in the literature. New business opportunities are, on average, evaluated as more crucial benefits of videoconferencing by adopters with a smaller level of experience. With increasing time of usage, the capability of this technology to help companies expanding business relations is seen as less important. This observation is not shared by most of the existing research. It, therefore, does not support the theory of stimulation of travel needs through such beneficial impacts of videoconferencing on the scope of businesses of a company. On the other hand, it is often reported that new adopters evaluate the generation of business relations as a key driver and try to quantify the benefit in their investment justifications as revenue potential.

Overall, in the survey results, the tendency is apparent that for companies with a longer experience in corporate videoconferencing, travel cost and time savings are the most significant benefits. However, strategic benefits as faster decision-making and enhanced competitiveness are gaining in relative importance, particularly for companies with more than five years of experience. More recent adopters also see travel substitution as important benefit. Nevertheless, in relative terms, it is much less a dominant factor. Particularly competitiveness and new business opportunities are seen as similarly or even more crucial.

3.8.2 Limitations of Videoconferencing

After discussing the wide range of benefits identified with respect to videoconferencing use in a corporation, this part stresses that still many limitations are associated with videoconferencing, which impede a more widespread adoption of the technology by the business community. The following discussion subdivides the existing obstacles in technical, social and psychological, cultural and other barriers (see Table 3.8.2-1).

Table 3.8.2-1: Limitations of Videoconferencing

Technical Limitations
<ul style="list-style-type: none"> ➤ Video-audio performance (e.g., low data transfer speeds, low frame rates, poor motion compensation, transmission delays, limited video-audio synchronization). ➤ Lack of standardization ➔ limited interoperability. ➤ Infrastructural problems: Need for accelerated expansion of fiber-optic network; currently, still heavily using phone-lines. ➤ Support for external devices and file formats ➤ Ease and convenience of use. ➤ Service reliability and availability.
Social and Psychological Barriers
<ul style="list-style-type: none"> ➤ Videoconferences decreases sense of inter-person contacts. ➤ Lack of personal interaction due to limitations of body gesture, reaction, facial language, and eye movement and contact. ➤ Frustration with tele-medium. ➤ Limited privacy, trust, and managerial overseeing (particularly in sensitive meetings). ➤ Secondary incentives of travel: Lack of social and recreational opportunities associated with business travel; travel as status symbol and break from office routine.
Cultural Obstacles
<ul style="list-style-type: none"> ➤ In some areas of the world, still limited acceptance of use of videoconferencing for face-to-face interactions, traditionally requiring physical presence of participants. ➤ Cultural rules as regards meeting proceeding and attendance.
Other Limitations
<ul style="list-style-type: none"> ➤ Cost. ➤ Opportunity to meet in higher frequency might lead to redundant and "useless" meetings ➔ increased unproductive time spent in meetings. ➤ Time-zone differences. ➤ Security breaches; particularly a concern with respect to security sensitive meetings.

Technical Limitations

In the technical area, video-audio performance is an apparent problem for business conversations in need of high-quality transmission, e.g. transmitting of body language and facial expressions, and involving a high degree of give and take requiring high-quality audio performance and video-audio synchronization. Particularly in multipoint applications, spontaneity of communication and interactions among participants are limited by poor video-audio synchronization and transmission delay.

In section 3.3.2, it has already been stated that audio quality in videoconferences is, in most cases, less acceptable than video quality. Slightly "fuzzy" pictures of participants or less accurate letters in view graphs may not destroy a meeting, as the inability to clearly hear what is said. Particularly in the time of early adoption to videoconferencing in the 1980s, many videoconferencing applications failed due to poor acoustics (Johansen, Bullen 1983: 7). How critical audio is for videoconferencing is revealed by several surveys indicating that, on average, 60% to 70% of information in a video meeting is conveyed through sound (Finn, Galanin October 11, 1993: 45).

Common video deficiencies that users notice are bad motion compensation and frame rate slowdowns. As with poor audio transmission, these deficits considerably hurt communication, particularly when spontaneous exchange is essential.

Limits in video-audio performance combined with lacks in standardization and, therefore, interoperability between conference systems are the most significant problems for the acceptance of desktop video applications in the business community.

The problem of standardization and interoperability due to proprietary compression technologies and algorithms used by manufacturers has been addressed in section 3.3.3. For many users, this might be the largest annoyance, especially if videoconferencing should be employed for inter-company meetings. The availability of bridging software can help but at a cost of degraded video-audio quality. Nevertheless, the increasing agreement about specifications of international standards in the videoconferencing area is expected to eliminate the still evident interoperability problems and may contribute to further declines in prices; it, therefore, is seen as a significant factor for future market growth of videoconferencing.

Infrastructural problems have been discussed in section 3.3.1. A wider adoption of videoconferencing, particularly in peripheral business centers, strongly depends on the fiber-optic network development, allowing high-quality digital data transmission. Today, videoconferencing heavily relies on phone-lines and is despite sophisticated compression technology limited in data transfer capacity. As stated in section 3.3.1, there is a need for modified state policies as regards telecommunications infrastructure to accelerate network upgrading in the U.S.

Also, the support for external devices and file formats is often named as a technical deficiency of videoconferencing. Facilities have to be equipped with various support equipment (visual aids, screen sharing, whiteboard technology, fax, etc.) to allow interactions close to in-person atmosphere.

Ease of use and service availability and reliability are further aspects that may be a matter of concern.

Social and Psychological Barriers

The question whether a meeting can be performed without physical presence depends widely on the social and psychological significance of the communication involved. Thereby, the acceptance of videoconferencing as meeting alternative is often seen as a function of time, increasing with growing experience. The lack of personal interaction is widely associated with the deficiency in using and recognizing body gesture, reaction, facial language, and eye movement and contact. These and other limitations may lead to frustration with the tele-medium. Furthermore, managers are often worried about limited privacy, trust, and managerial overseeing, particularly in sensitive meetings.

Secondary incentives of travel associated with social, cultural and recreational opportunities cannot be provided through videoconferencing. Social activities involved in business travel are often seen as important communication channels, which cannot be replaced by electronic media, especially in executives' meetings. Many middle and senior managers also view business travel as a job prerequisite and privilege, e.g., as a status symbol, or break from office routine.

Cultural Obstacles

Also in the cultural area, acceptance limitations of videoconferencing as a substitute for face-to-face communication traditionally requiring travel of participants is apparent. Cultural rules as regards proceeding of, and attendance at meetings exist in some parts of the world, e.g., the form of gathering around a conference table by people of different hierarchical levels. These obstacles may be difficult to remove in the international area. However, their significance for videoconferencing applications in the U.S. and Europe is widely assessed as low.

Other Limitations

Besides technical, psychological/social and cultural barriers, problems exist also in some other areas. As the subsequent discussion of results of the videoconferencing user survey for this study shows, costs of videoconferencing are still seen as one of the most critical barriers for a wider adoption. In addition, time-zone differences considerably limit the scope of international videoconferencing applications; a problem that may be difficult to solve.

Some researchers and users also suggest that due to the ability to schedule meetings easily and at short notice, often videoconferences are conducted that are redundant and "useless". The necessity of a face-to-face meeting is not as critically assessed as in case of in-person meetings, leading to an increase of unproductive manager time spent in meetings.

Moreover, the possibility of security breaches in videoconferencing is sometimes stated as a manager concern, especially with respect to security sensitive talks.

M.I.T. Survey

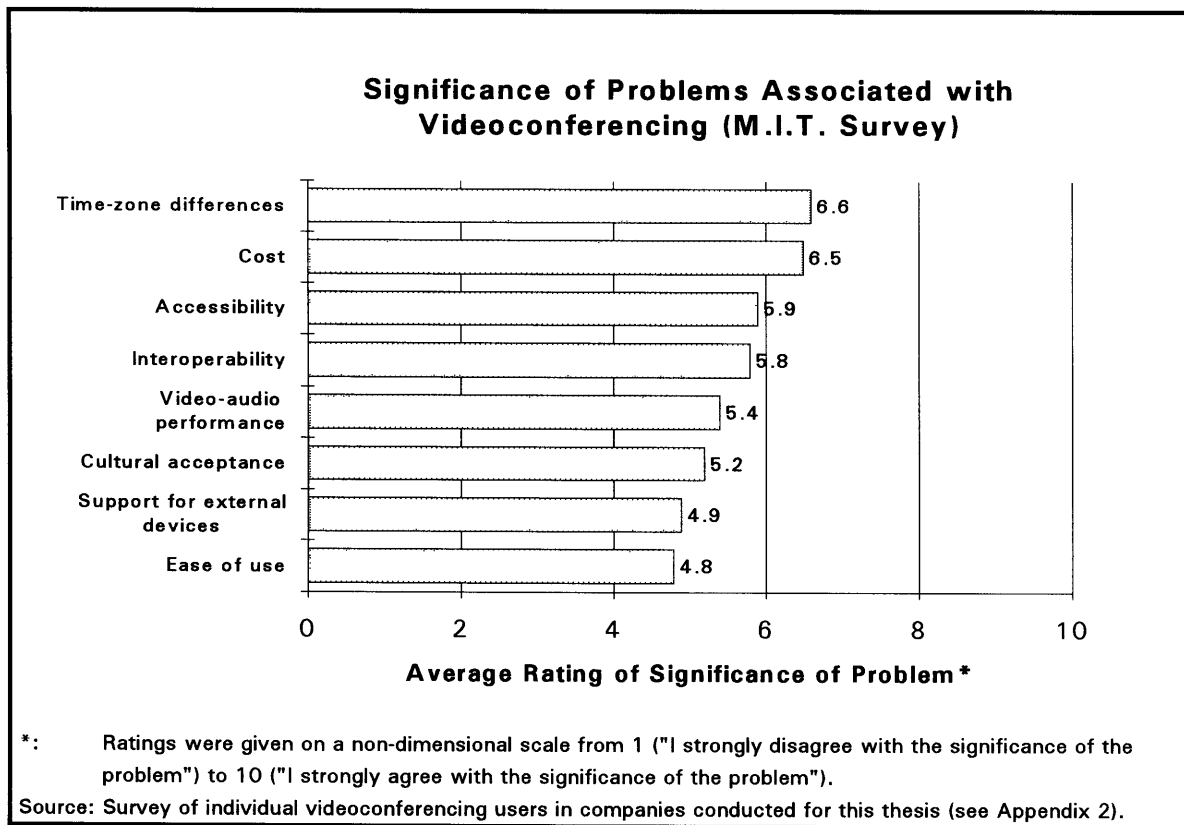


Figure 3.8.2-1: Significance of Problems Associated with Videoconferencing (M.I.T. Survey)

In the videoconferencing survey for this thesis (Appendix 2; user survey: 6c), individual users of this technology in corporations were asked to assess different potential problems often named with respect to videoconferencing on a non-dimensional scale from 1 ("I strongly disagree with the significance of this problem") to 10 ("I strongly agree with the significance of this problem").

The assessment profile for each criterion included in this questionnaire is very heterogeneous. On average, no aspect is seen as a significant barrier. On the other hand, no problem is really rejected. Rather indifferent average ratings from 4.8 to 6.6 are determined for the individual criteria (see Figure 3.8.2-1).

According to the respondents to the questionnaire, time-zone differences in international applications (average rating: 6.6; 25% of respondents rated it with 10) and the cost of videoconferencing (6.5; 25% of respondents rated it with 9 or 10) are seen as the most significant barriers, still limiting a more extensive usage of the technology in their businesses. On the other hand, the capability to support external devices and file formats (average: 4.9) and the ease of use (4.8) are assessed, on average, as the least significant constraints on videoconferencing applicability. Technical aspects as video-audio performance (5.4) and interoperability (5.8), as well as accessibility to facilities (5.9) and cultural acceptance problems (5.2) received moderate and rather indifferent average ratings.

4 IMPACT OF VIDEOCONFERENCING ON AIR TRAVEL DEMAND

4.1 Interrelationship of Enhanced Telecommunications and Business Travel

Telecommunications and transportation are essential for the functioning of today's economic and social systems. However, their relationship is both competitive and complementary. Especially with respect to advanced teleconferencing technologies as videoconferencing, telecommunications are assessed as significant challenge for the transportation sector and the airline industry in particular. As the discussion throughout this section shows, interactions between telecommunications and transportation have been an issue for much speculative assessment but little empirical research. Furthermore, most studies are widely biased in their approach since they tend to focus only on the potential substitution of transportation services through telecommunications. Thereby, they neglect the much more complex complementary interaction potential of both modes (Bennison 4/1988: 291). This apparent lack might be primarily due to the simpler modeling of the substitution relationship compared with the principles of travel modification and stimulation.

This section introduces the discussion of the relationships between videoconferencing and business air travel. In this context, questions are raised which are not limited only to the most probable form of the impact on business travel, the extent of that impact, or the time when certain levels of the impact are reached. Subsequent sections show that the relationship is highly complex and that a very close look at the underlying factors is important in order to identify dependencies, sensitivities, and other trades in that relationship.

This section begins with a short discussion of historical trends and their interpretation. Then, a description of the potential interactions between enhanced telecommunications and travel is provided. Finally, the experience and evaluations of the users of videoconferencing regarding the impact of this technology on their need to travel are addressed.

4.1.1 Historical Observations and Interpretation

The issue of telecommunications versus transportation has already been subject of extensive research and discussion throughout the past two decades. New developments and technological breakthroughs in the telecommunications area have

always made researchers and analysts confident that, in the future, telecommunications would have the capability to replace physical travel significantly, thus, reducing the volume of transportation or at least its relative growth rates (Economic Research Centre 1983: 73).

However, most researchers today agree that such past projections have not occurred. Newer means of communications have contributed very significantly to the efficiency of the communications systems as a whole, but there is no evidence that they have also had any considerable effect on the growth of transportation (Economic Research Centre 1983: 73). Several researchers see in these historical trends a proof for the existence of a complementary relationship between telecommunications and transportation, meaning that advances in telecommunications may lead to more travel, while better transportation systems contribute to greater demand for telecommunications. Today, telecommunications and transportation are so integrated into each other that the transportation sector -- e.g., automobiles, high-speed rail, and airlines -- feels compelled to install telecommunications media, such as phones or fax, in autos, railcars, and aircraft so that people can travel and communicate simultaneously and, thereby, enhance their personal productivity (Saffo Autumn 93: 112-116).

4.1.2 Potential Impact on Business Travel

The relationship between modern telecommunications, particularly videoconferencing, and business travel is more complex than a simple trade-off mechanism implicit in the substitution hypothesis. Besides the replacement of travel by videoconferencing, two alternative forms of interaction are identified in the literature: the stimulation of new travel, and the modification of travel patterns as result of the use of enhanced teleconferencing systems. All three types of interaction are discussed in this section.

4.1.2.1 Substitution of Travel

When the media offer comparable "richness", as videoconferencing and natural face-to-face meetings do, convenience and cost may be the deciding factors in the choice of one or the other. This implies the existence of a competitive relationship, which would result in increased substitution of travel by videoconferencing since the latter technology is continuously improving its performance in terms of quality, convenience, and cost relative to travel (Svenning, Ruchinskas, Hart 1993: 78).

Therefore, the scope for replacing business travel by videoconferencing is related to two principal considerations: the suitability and capability of videoconferencing for the performance of specific communication tasks involving certain types of travel, and the comparative costs of both modes (Bennison 4/1988: 291). However, in this context, it must be considered that videoconferencing may be technologically and economically conceivable, but, at the same time, may not be socially effective for particular purposes.

The scope of transportation substitution by telecommunications is usually considered in relative terms, implying that enhanced telecommunications may not have the effect of reducing overall demand for business travel but "only" the rate of its growth. At the same time, the share of travel in business communications as a whole would diminish while that of teleconferencing would increase (Economic Research Centre 1983: 22).

The substitution effect of modern telecommunications on air travel can also be seen on a long-term basis. Advances in telecommunications may have an impact on the level of investment in transportation infrastructure in a country, especially in a developing country. Assuming such countries with limited funds to invest, they may have to decide between an investment in airport capacity or telecommunications technology (Wineberg 1992).

The research on the substitution potential of telecommunications for travel primarily comprises the following five applications (Mokhtarian 3/1990: 234): (1) telecommuting (working at home or other remote locations with telecommunication links to central office), (2) teleshopping (using computer or TV-based services to obtain information about, and sometimes to purchase, products), (3) telebanking (using a computer with modem and/or telephone to perform banking transactions), (4) tele-entertainment (the use of telecommunications to transmit a cultural, athletic, or other entertainment activity to multiple locations), and (5) teleconferencing, extensively discussed throughout section 3.

With respect to air travel, only teleconferencing and its most advanced form, videoconferencing, are considered to have a substantial effect. The other applications listed above affect more regional and urban surface transportation, or allow communication links that were not possible before.

In addition, air express transportation can be substituted by telecommunications. Some documents now transmitted via fax or electronic mail would have been sent a

few years ago by overnight or conventional mail (Mokhtarian 3/1990: 235). However, the discussion in this thesis is focused on interactions of enhanced teleconferencing technology and business passenger travel and does not integrate freight transportation issues.

4.1.2.2 Stimulation of Travel

Opposed to the substitutional interactions between telecommunications and travel, the effect of stimulation of demand for travel due to an increased and/or cheaper contact made possible by modern telecommunications is more indirect, and has a long-term perspective. Therefore, it is more difficult to perceive, measure, and quantify.

The theory of stimulation suggests that increased contacts through enhanced telecommunications may generate a new need for more natural face-to-face contacts through physical movement. Telecommunications, therefore, expand the number and geographical scope of economic and social relationships in which people or organizations engage and enlarge the need to travel, in addition to the overall communications volume.

This complementary relationship also implies that improved passenger transportation may increase the demand for communications. Apparently, in this body of literature, there is a lack of convincing empirical work (Selvanathan 1/1994: 1).

Mokhtarian (3/1990: 235/36) subdivides the complementary relationship between telecommunications and travel in three categories: (1) short-term direct, (2) short-term indirect, and (3) long-term.

Short-term direct stimulation means that telecommunications make information about people and activities in dispersed locations much more accessible than would otherwise be possible. This capability causes people to initiate travel to a destination after using telecommunications to find that the trip will be necessary, beneficial, and/or productive. In addition, the ability to continue to communicate globally while traveling may itself stimulate directly more travel, or at least inhibit attempts to reduce it (Mokhtarian 3/1990: 235).

Short-term indirect stimulation implies that the time saved by substituting certain travel purposes by teleconferencing may be used to engage in other businesses and to make other trips that in the past were foregone because of time constraints. For example, a company with an in-house videoconferencing system

often does not experience a reduction of overall travel volume and expenses, as videoconferencing meetings are supplemented by other business trips -- perhaps more desirable and/or more essential (Mokhtarian 3/1990: 235; KJH Communications 1994: 4-2).

Also, **long-term** stimulation effects are possible. Developing telecommunications infrastructure and services may lead to long-term changes in land-use patterns -- e.g., more dispersed residential and employment locations -- that may in turn result in longer and more travel in general (Mokhtarian 3/1990: 236). However, the geographical scope of these effects is widely concentrated on more regional and urban areas. On the other hand, as discussed in section 3.7.2, telecommunications also contribute to changes in organizational, corporate and competitive patterns, leading to more cooperation among geographically dispersed business sites on a domestic and international basis and to more competition of wider geographical scope; and, therefore, generating new travel needs.

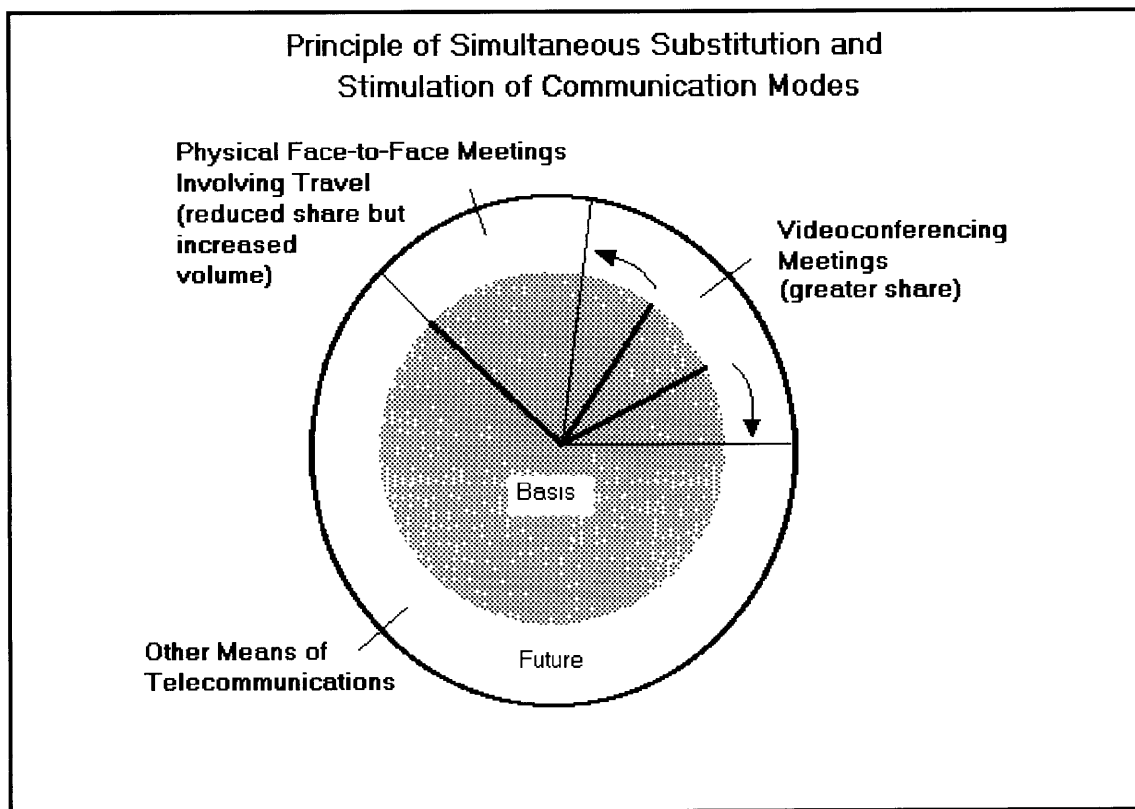


Figure 4.1.2.2-1: Principle of Simultaneous Substitution and Stimulation of Communication Modes

However, the stimulation of travel as consequence of enhanced telecommunications does not imply that the relative share of physical face-to-face meetings

in communications as a whole remains steady, or even increases. Telecommunications -- even according to the hypothesis of stimulation -- partially substitute for business travel; but, due to the effects discussed above, the absolute amount of communication via each mode -- therefore, also through natural face-to-face meetings -- is likely to increase. Figure 4.1.2.2-1 illustrates this principle of simultaneous substitution and stimulation of communications modes.

The actual amount of personal business travel increases as part of a general expansion in communications due to videoconferencing and other multimedia applications, even though its relative share as a communications mode declines. It is the combination of these counteracting forces that makes it so difficult to determine the net impact of videoconferencing on business travel (Mokhtarian 3/1990: 236).

4.1.2.3 Modification of Travel Patterns

The theory of modification of travel patterns as consequence of enhanced telecommunications suggests that transportation demand is modified in time and/or place, without any overall changes in total volume. This may result from changes in organizational structure, e.g., decentralization, or relocation of activities facilitated by telecommunications (Bennison 4/1988: 291). This effect is of an indirect and long-term nature.

Another form of modification of air travel demand is suggested by Wineberg (1992). Advanced telecommunication applications in the business world might lead to a change in the mix of travel types, without reducing the overall amount of air travel. This hypothesis assumes that productivity and efficiency gains from use of teleconferencing do not only imply more time for other business but also more leisure time, which might be used for more travel for pleasure purposes. Therefore, pleasure travel would replace business travel substituted by new means of telecommunications. However, this trade is obviously not favorable for the airline industry due to the significantly reduced passenger revenue associated with pleasure travel.

4.1.2.4 Additional Considerations with Respect to Substitution versus Stimulation

Khan (1987: 4/5) suggests several other considerations that may have an effect on the use of telecommunications and air travel: (1) different cost and time differentials for short and long-haul trips, (2) convenience of same day return, (3)

relatively low motivations to travel for frequent trips to same destination, and (4) social, cultural and recreational attractions of international travel.

The main attributes for assessing the desirability of travel and telecommunications perceived by the consumers are the following, according to Khan (1987: 13/14):

- ✧ *Cost of usage*
- ✧ *Time*
- ✧ *Service availability* (probability of getting service at desired time and frequency)
- ✧ *Comfort & convenience* (service reliability & quality, access/egress)

As already discussed in section 4.1.2.2, trip substitution due to the increased usage of teleconferencing arises simultaneously with travel demand generation and the overall growth of communications. Figure 4.1.2.4-1 illustrates a theoretical model of this interaction between transportation and enhanced telecommunications, highlighting that telecommunications are both a substitute and stimulant for travel. This graphic is a qualitative construction of plausible economic effects unrelated to any specific empirical data (Global Telematics 1994).

It is presumed that business transactions involving one of the two modes are a common metric for measuring telecommunications and travel. In Figure 4.1.2.4-1, the overall transaction volumes are represented as annual quantities in vertical bars. The bars are subdivided into four sections, two of which are representing travel transactions and two of which are telecommunications interactions. The telecommunications transactions comprise some that are substitutes for travel and others that bear no relationship to traveling. Similarly, travel consists of trips stimulated by telecommunications use and those that are independent of the latter one.

If telecommunication substitutional events add up to more travel miles saved than those generated by telecommunication-induced travel stimulation, then, substitution is the net result. Note that the overall travel volume can still be increasing in such a case. If the reverse is true, logically, stimulation is the net outcome. In Figure 4.1.2.4-1, telecommunication transactions substituting for travel have been arbitrarily set equal to the trips generated by the use of telecommunications. Therefore, the overall effect on travel is neutral.

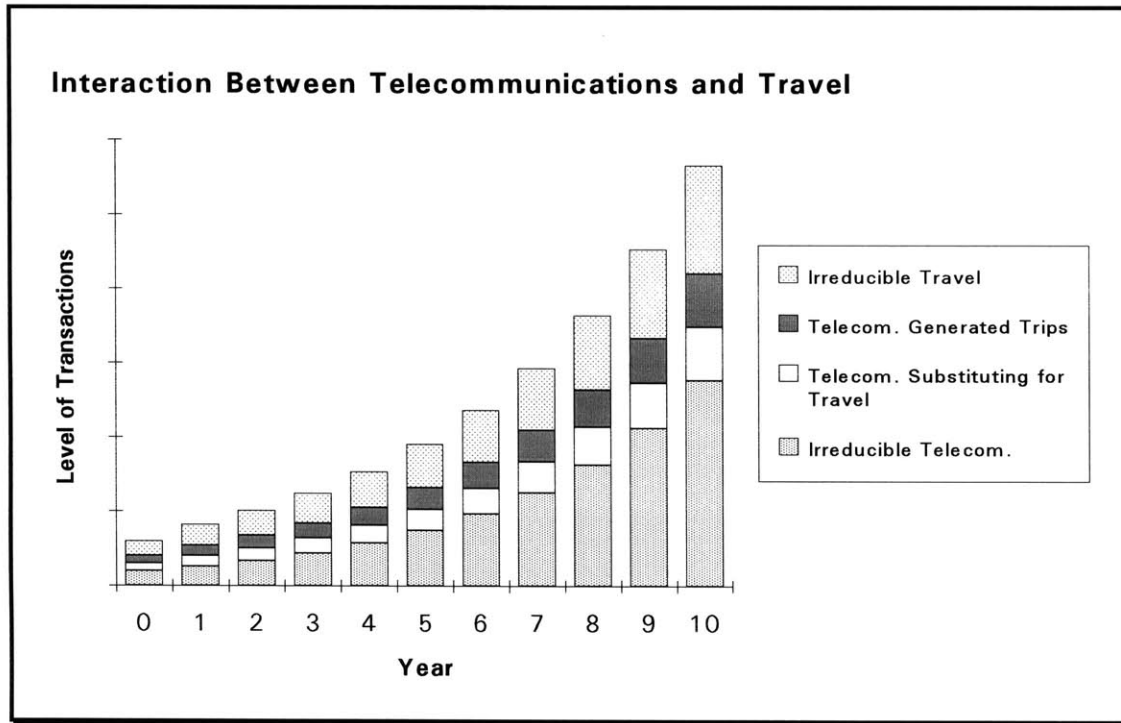


Figure 4.1.2.4-1: Interaction Between Telecommunications and Travel

In section 4.1.2.2, it was suggested that the stimulation effect outweighs the substitutional effect of teleconferencing; and, in spite of the relative decline of the travel share of total business communications, business travel will still increase in absolute terms. Whether this turns out to be true is an open question and subject of heavy argument, as shown in subsequent sections.

4.1.3 User Experience and Evaluation

After discussing potential interactions between videoconferencing and business travel, some examples of user experiences and evaluations are provided. Table 4.1.3-1 gives an overview of user assessments and observations, grouped in examples supporting the substitution theory, and those proving a neutral, or even positive, impact on travel through increased use of videoconferencing. Travel data achieved from the survey being conducted for the purpose of this thesis are not enclosed. They are separately discussed in section 4.4.

It is apparent that the experiences and evaluations of users are heterogeneous. However, the ratio between observations supporting the substitution theory and those rejecting this hypothesis shown in Table 4.1.3-1 is representative for what can be found in the literature.

Table 4.1.3-1: User Experiences and Assessments

Substitution of Business Travel
<p>☒ The study of Svenning, Ruchinskas, and Hart (1993: 78/79) suggests that travel declines as consequence of videoconferencing use. The majority (78%) of users responding to a survey of experienced videoconferencing users reported a decline in travel although they still have a personal preference for travel (76%).</p> <p>☒ An October 1992 survey by Opinion Research Corporation found that about 40% of all business respondents explained their decline in travel by reliance on telecommunications and particularly videoconferencing technology (Arthur D. Little 1993: 3-65).</p> <p>☒ Implementing videoconferencing systems saves, on average, 18% on corporate travel costs. This is the result of a survey by Telemanagement Resources International (TRI) among companies of the "Fortune 1000" industry group using videoconferencing (Finn, Galanin October 11, 1993: 41; Ann Earon, conversation with author).</p> <p>☒ Usage of videoconferencing facilities installed across Union Pacific's rail system and running on its own private digital network has substantially reduced the amount of the company's business travel and the associated unproductive manager time. The substitution ranges from 20% to 70% depending on department, staff level, and location (e.g., proximity to facility). The average decline in travel is quantified with 25% (Arthur D. Little 1993: 3-65).</p> <p>☒ Apple Computer estimated that it had cut travel costs by \$25 million in four years from 1989 to 1992 as a result of videoconferencing -- after spending \$6 million on hardware, transmission, and staffing for videoconferencing in this period (Kupfer December 28, 1992: 91/92).</p> <p>☒ Norfolk Southern Railroad justified videoconferencing among executives in its Norfolk, Virginia, headquarters and sites in Atlanta, Georgia, and Roanoke, Virginia, based solely on eliminated travel costs. The savings were estimated with more than \$50,000 per month - not considering executives' time savings, which are seen as the key benefit (Finn, Galanin October 11, 1993: 41).</p> <p>☒ Novacor Chemicals, Ltd. (Canada), justified its investment in videoconferencing by an estimated reduction of half of its company business travel for meeting purposes, representing approximately \$500,000 per year in travel cost savings. After the investment, this estimate was exceeded. The payback period for the \$285,000 investment in videoconferencing units for seven of its locations in 1992 was only four months -- not taking into account increased personal productivity (Blackwell November 1993: 90).</p> <p>☒ British Aerospace estimates it saved £980,000 (~\$1.5 million) on cost of time and travel through the implementation of two videoconferencing systems (Apogee 1994: 21).</p> <p>☒ Rank Xerox calculated cost savings of £2,700 (~\$4,000) per videoconferencing hour after linking its United Kingdom office with seven U.S. sites (Apogee 1994: 21).</p> <p>☒ Management Recruiters International (MRI), a U.S. executive search firm, plans to equip its 600 offices around the U.S. with videoconferencing systems. MRI estimates that it would eliminate about \$135 million annually in costs for clients that typically fly in around 90,000 people each year for first-round interviews (Apogee 1994: 21).</p>

Table 4.1.3-1 (Cont'd): User Experiences and Assessments

No Substitution of Business Travel	
☒	An informal survey among companies that operate teleconferencing facilities and corporate aircraft indicates that the use of audio- and videoconferencing systems does not impact the use of corporate aircraft. No correlation is apparent. Most companies have no formal procedures to decide when employees should use videoconferencing instead of traveling (Business & Commercial Aviation January 1994: 33/34).
☒	The majority of clients of Telemanagement Resources International find that travel is not notably affected by the use of videoconferencing although most of them justify the investment initially with travel cost savings. Several users even experience an increase of travel as result of videoconferencing (Feldman 9/1993: 46).
☒	AlliedSignal estimated savings of \$360,000 a month on air travel due to videoconferencing before investing several million dollars in a system equipping 72 sites. Once installed, the equipment helped the company increase its communication flexibility and improved many internal processes, but travel turned out to be less of a driving factor (Hughes November 29, 1993: 40).
☒	Unisys does not evaluate travel savings as a driver for an investment in videoconferencing and other multimedia systems. The dynamics and patterns of business travel would change and a re-allocation of travel dollars within the company would occur as result of these telecommunications technologies, but the overall travel budget remains unaffected. On the contrary, new business opportunities are provided through videoconferencing, generating new needs to travel (John Champa, manager for videoconferencing at Unisys, interview with author).
☒	The Environmental Protection Agency (EPA) having installed videoconferencing systems in ten regional offices has not seen a reduction in money spent on travel as consequence of this. Most meetings held might not have been conducted at all prior to the investment, in which case no travel costs were saved (Feldman 9/1993: 48).

It has been stated earlier that most of the existing research focuses on travel substitution by telecommunications. This bias in study orientation also implies the search for corresponding examples, leading to a possible overweight of examples in the literature that support the hypothesis of substitution.

However, it is also true that it is very difficult to measure and quantify the modification or stimulation of travel. Most estimates and quantifications of travel substitution are based on project-specific data and observations. After using videoconferencing in specific projects, a decline in travel is often experienced. Nevertheless, these approaches neglect that substitution is often the first direct effect of using videoconferencing, whereas travel stimulation or/and travel modification occur on a more long-term indirect basis, and are not limited to certain projects but have a wider scope.

Furthermore, there can be a variety of factors underlying trends in a company's travel budget, particularly during economically weak periods. These are often not

sufficiently considered in the travel saving quantifications. It is questionable to what extent the specific contribution of videoconferencing to any declines in travel budget can be filtered out and isolated from all the other external and internal factors impacting budget trends.

Finally, the interesting trends apparent in IATA's annual "Corporate Air Travel Survey" should be briefly addressed (IATA April 19, 1994; Peter Morris, responsible for IATA's travel surveys: interview with author). As stated in section 2.4.2, 9% of respondents (business travelers) flying economy class and 5% of those flying first or business class evaluated an increased use of telecommunications as the most probable response to cuts in their travel budget. In addition, the respondents were almost evenly divided in their assessment whether modern telecommunications will replace travel. While in 1992, only about 40% agreed that telecommunications have the potential to substitute for business travel, this figure increased to approximately 55% in the 1994 survey.

4.2 Existing Studies and Analyses

In this section, several important existing studies in the field of telecommunications versus inter-city business travel are discussed. The most recent contributions to the issue of the interaction of enhanced teleconferencing technologies and business air travel, which received a wide attention by the airline industry, are specifically addressed. Before the existing research is introduced and evaluated, the types of approach and methodology employed in the professional literature in this field should be discussed.

4.2.1 Types of Approach and Methodology

Extensive research on telecommunications impacts on transportation has been conducted throughout the last two decades, with particular concentration at the end of the 1970s and early 1980s, when oil crises and economic recession aroused interest in the possibility of effectively substituting certain forms of transportation by telecommunications. These examinations were often performed on a macro-economic scale, considering economic and transportation policies, as well as energy savings and -- in the 1980s increasingly -- environmental aspects.

In most of these studies, the general means of telecommunications and transportation have been analyzed. However, the relationship between teleconferencing and business air travel is often a subject of specific examination. Videoconferencing

is widely identified as having the most significant potential to impact business air travel since it addresses the same communication need as the latter one: interactive face-to-face communication.

Furthermore, certain theoretical relationships, characteristics, and factors underlying the general interaction between telecommunications and transportation are applicable to the issue of video-teleconferencing versus business air travel. Even interactions between teleconferencing media and travel studied on a more regional or urban basis contain arguments and assessments that should be considered with respect to the problem of inter-city business air travel.

While the effect of telecommunications on the transportation sector as a whole and particularly on regional and urban surface transports (telecommuting) has been the subject of extensive research in the past two decades, the issue of modern teleconferencing versus air travel has not been more specifically and systematically examined until the recent few years.

The most important contributions to the field of air travel (Apogee 1994, Arthur D. Little 1993, Arvai 1994), which were accessible for the purpose of this analysis (at least in form of summary reports), are integrated into the following discussion and are of particular interest since they have caused the airline industry to turn their attention more seriously toward this issue. However, it must be understood that the proprietary nature of most of these studies has not allowed a full access, particularly to data sources, and, therefore, a complete analysis of all assumptions and modeling approaches that support the final results has not been possible.

The methodologies and approaches to the issue of telecommunications versus business air travel in the professional literature can be subdivided in the five following basic categories (see Table 4.2.1-1):

- ① Intuitive Judgment
- ② Statistical Analysis
- ③ Opinion Survey with Hypothetical Choices
- ④ Field Trial
- ⑤ Empirically Based Model

This classification is based on a study of the National Transportation Policy Study Commission (NTPSC; 1978: 14-16), which identifies four of these forms. There, the category "statistical analysis" is part of "intuitive judgment". However,

since a statistical analysis can be evaluated as more analytical, and hopefully, as being of a greater level of objectivity than a mere judgmental assessment, it is identified as a specific form of approach in this thesis.

It is important to consider that these approaches are normally not separately employed. Studies in the literature in this field usually comprise more than one of these approaches. For example, an extensive statistical analysis can be the basis for a subsequent intuitive judgment. A field survey is prerequisite for the development of a formal mode-choice model, which itself may contain a good amount of subjectivity similar to any judgmental approach.

Intuitive Judgment

The use of intuitive judgment is self-explanatory. Although often based on certain statistics of trip purposes and actual magnitudes of travel for each purpose - - which are rarely available in a reliable form, this approach is very qualitative and in several cases highly speculative. Judgmental and subjective arguments are made as to which trip category would be most susceptible to substitution or stimulation, which then leads to estimates for the amount of travel substitution or stimulation that can be expected for each trip category.

Most studies that can be found in this field of telecommunications versus transportation rely heavily on this kind of judgmental and qualitative approach, even if some more empirical and/or analytical analyses are included.

Statistical Analysis

Statistical analyses are of a more analytical and objective nature. However, as said earlier, the interpretation of results and their application to the discussion of the interaction of telecommunications and transportation still requires judgmental and qualitative evaluations. After recognizing specific trends and characteristics in the statistics for certain business activities, the estimation of the absolute demand substitution/stimulation requires a quantification of the sensitivity of each business travel category to telecommunications. This is often achieved on a judgmental basis, rather than through analytical or empirical examinations.

Statistical analyses in this field usually comprise an identification of trends in demand for certain travel purposes, a regression that models the correlative relationships between travel demand and socio-economic factors, an attempt to

integrate telecommunications trends into such a demand model, and, then, the projection of future demand on basis of the historical correlation model.

Some studies being discussed in section 4.2.2 base their approaches on such a regression analysis.

Opinion Survey with Hypothetical Choices

Through the use of surveys with hypothetical choices, an attempt is made to achieve a greater level of objectivity than in the case of relying on intuitive judgment. In such surveys, often applied in the airline industry, a particular group of traveler, e.g., business air travelers, is identified and then surveyed. The survey typically presents the traveler with a series of choices between the transportation mode presently being used for a given trip and several alternative hypothetical telecommunications options ("Would you have used videoconferencing for this trip if you would have had access to such facilities?"). Estimates of potential diversion to telecommunications for various trip purposes are the final output of such an approach (NTPSC 1978: 15).

However, predicting market response on basis of what people say they would do if presented with new technologies contains several limits. Such projections are sensitive to the structure and exact phrasing of the survey, are influenced by respondents' desires to give "right" answers, and have a severely limited validity when the magnitude of innovation is large (Salomon, Schofer 3/1988: 226). In addition, the validity depends on the level of experience that the people being surveyed have with videoconferencing and other modern teleconferencing technologies. Furthermore, even if assessing certain meeting purposes as currently substitutable through videoconferencing, the question remains, to what extent this traveler will have access to modern videoconferencing systems in the future to realize such an intention.

Also, personal preferences for business travel (secondary incentives), e.g., international travel to destinations with social, cultural and/or recreational attractions, might induce the choice of travel, even if an alternative meeting form would be capable to effectively fulfill the business needs.

Overall, such attitudinal approaches tend to produce overly optimistic predictions of adoption rates (Salomon, Schofer 3/1988: 226).

Surveys with hypothetical choices are only partially employed in the studies subsequently discussed. However, their limitations should be also considered with respect to results of IATA's "Corporate Air Travel Survey" presented in section 4.1.3.

Table 4.2.1-1: Types of Approach and Methodology Employed in Literature

Intuitive Judgment
<ul style="list-style-type: none"> ↖ Highly qualitative and speculative though often based on statistical data for categories of trip purposes. ↖ Judgmental argument is made as to what extent specific trip categories are sensitive to substitution/stimulation → estimates for the amount of total travel substitution/stimulation by certain point of time. ↖ Most studies rely heavily on such qualitative and subjective assessments.
Statistical Analysis
<ul style="list-style-type: none"> ↖ Approach of a more analytical and objective nature. ↖ Analyses comprise identification of trends in demand for specific trip purposes, recognition of correlation between demand and different socio-economic factors, as well as trends in telecommunications area, and future demand projections. ↖ Nevertheless, in need for judgmental assessment with respect to estimation of substitution/stimulation potential of specific trip categories, interpretation of results, and/or application to telecommunications-transportation interaction. ↖ Applied in some studies.
Opinion Survey with Hypothetical Choices
<ul style="list-style-type: none"> ↖ Greater level of objectivity than intuitive judgment. ↖ Identification of representative group of people, e.g., business air travelers; surveying people by presenting them with a series of hypothetical choices between traveling and telecommunications use. ↖ Outcome: estimates of potential diversion from travel to telecommunications. ↖ Several limitations, e.g., sensitivity to structure and phrasing of data collection instrument; limited validity when magnitude of innovation large and level of experience of people surveyed low; personal preferences (secondary incentives) of travelers causing choice in favor of travel even if telecommunications medium would be effective for meeting purpose (in survey, assessed as substitutable). ↖ Predictions of adoption often overly optimistic. ↖ Only partially employed in literature analyzed in this study

Table 4.2.1-1 (cont'd): Types of Approach and Methodology Employed in Literature

Field Trial
<ul style="list-style-type: none"> ↗ Using actual experimental and operational teleconferencing applications in gathering user evaluations, preferences and characteristics (costs, frequency of use, types of usage, acceptance, impact on travel volume and patterns, etc.). ↗ Completion of questionnaires by users. ↗ Also, limitations: finding of representative user groups, focus on specific projects using videoconferencing, neglecting far-reaching, indirect, long-term interactions. ↗ Although empirical, interpretation of data and user responses on judgmental basis. ↗ Employed in this study; questionnaire among companies using videoconferencing elementary component. ↗ Increasingly employed in research but still evident lack in reliable empirical data.
Empirically Based Model
<ul style="list-style-type: none"> ↗ Most widely accepted approach; however, also most rarely employed by now in scientific literature due to lack of empirical data for model calibration and development; no example known with respect to issue of teleconferencing versus air travel. ↗ Extrapolations of observed behaviors and projections of future interactions. ↗ Based on mathematical relationships and in need for empirical data. ↗ Such behavioral models do not eliminate reliance on judgment.

Field Trial

Field trials make use of actual experimental or operational teleconferencing systems in gathering user preferences and characteristics. Costs, frequencies of use for certain purposes, user acceptance, impact on personal travel needs, for instance, can be directly examined and by means of questionnaires completed by users. Such an empirical approach is also an elementary part of this study although some more hypothetical questions regarding the use of videoconferencing and its impact on travel are also integrated (see discussion in section 4.5).

Research in this area relies on empirical data although significant deficiencies are apparent. Several studies discussed in section 4.2.2 base their assessments on

such field trials. However, as stated earlier, the proprietary nature of these data has not allowed a closer look at survey structures and results.

Often, it is questioned as to what extent the data collected are really representative. Researchers in many cases tend to use early adopters -- large companies -- for their field trials. However, their behavior and preferences may not reflect those of the general market. This limitation, to some extent, is also associated with the M.I.T. survey conducted for the purpose of this study, which basically comprises firms of the "Fortune 500" industry group.

Furthermore, as stated before, the focus on specific videoconferencing projects and the derivation of estimates for the general impact on business travel based on such particular observations may have limited validity.

Although field trials are empirical, they still require a qualitative and judgmental interpretation of data and survey results.

Empirically Based Model

The most widely accepted "scientific" approach of forecasting is the use of empirically based mathematical models to extrapolate behaviors observed in specific situations. Such tools explicitly accommodate extant knowledge through mathematical relationships. However, such formal models do not eliminate the reliance on judgment (Salomon, Schofer 3/1988: 226).

Due to a lack of reliable empirical data that are a critical ingredient for calibration and model development, and due to an insufficient understanding of the behavioral relationships, the methodology has only rarely been used. Applications to the problem of teleconferencing versus business air travel are not known (NTPSC 1978: 16).

Examples of such behavioral demand models can be found in Khan (1976: 217-246; 1985: 297-316). Nevertheless, Khan did not employ formal demand models in his study of telecommunications-air travel interactions (1987) due to a lack of reliable empirical data for model calibration and development.

4.2.2 Assessment of Existing Research

From the existing literature, important and interesting contributions that address the impact of teleconferencing on business air travel are assessed in this section. The selection of these studies does not claim completeness due to limited

accessibility and availability of research papers. In certain cases, the proprietary nature of the study prevents a complete access to methodology and data sources. In such cases, the discussion is based on summary reports, presentation hand-outs, and interviews with people responsible for it.

The categorization of studies chosen in this section is not based on the classification of approaches discussed in section 4.2.1 since most studies incorporate more than one of these basic types of approach. Therefore, the subdivision applied in the following distinguishes between qualitative and theoretical analyses (4.2.2.1), and studies developing quantified forecasts and estimates (4.2.2.2).

However, even in case of studies focused on quantifying impact of modern telecommunications on travel, these quantifications are not solely based on statistical, empirical and/or analytical methodologies. In many cases, they heavily rely on intuitive judgment and are highly speculative. On the other hand, studies classified as theoretical and qualitative also address quantifications of the telecommunications impacts. Nevertheless, these are not systematically derived but primarily quoted from existing studies and survey results.

The following analysis of existing research studies is structured by an addressing of objectives/purposes, a description of approaches/methodologies chosen, a discussion of results and conclusions, and, finally, an overall evaluation and judgment of each individual study. To each research work being discussed, an associated table is provided giving detailed information. Section 4.2.2.3 contains the overall comparative assessment of the studies discussed.

4.2.2.1 Qualitative and Theoretical Analyses

Studies by NTPSC (1978), Economic Research Centre (1983), and Tealeb/Orton (1985); Table 4.2.2.1-1 to 4.2.2.1-3

Three early research works that are very similar with respect to their objectives, approach, and results are addressed initially. All three studies focus on the general relationship of telecommunications and transportation. In addition, economic and transportation policy considerations and aspects of energy conservation and environmental impacts of transportation are included.

However, all three studies specifically discuss the interaction of teleconferencing and inter-city business travel. The identification of significant trends

and general factors underlying this interrelationship is addressed. A review of existing research, the discussion of exemplary case studies and survey results, and the recognition of research opportunities are elementary components.

Table 4.2.2.1-1: Study by National Transportation Policy Study Commission (NTPSC; 1978)	
Objectives	<ul style="list-style-type: none"> ➤ Recognition of general factors underlying relationship of telecommunications and transportation; focus on regional and urban basis, and also integration of good-movements; however, also addressing inter-city travel and its sensitivity to telecommunications. ➤ Consideration of economic and transportation policies including potential for energy conservation through substituting transportation by telecommunications. ➤ Recognition of research opportunities.
Approach	<ul style="list-style-type: none"> ➤ Analyzing concepts & approaches employed in literature, and qualitative discussion of those. ➤ Interpreting survey results, and basic attempt of scenario development and model building using these survey data.
Results	<p>Related to inter-city travel:</p> <ul style="list-style-type: none"> ➤ Recognition of evident lack of empirical studies and data. ➤ Important to distinguish between substitutability (upper bound) and substitution (actual amount) of travel. ➤ Based on existing studies and surveys, estimate for substitution potential of inter-city travel of 20% - 36%; substitutability even higher at about 50%.
Judgment	<ul style="list-style-type: none"> ➤ Bias: Focus on substitution, neglecting more complex relationships associated with stimulation and modification of travel. ➤ Several deficiencies, which make study only partially useful for today's discussion, e.g., time of study (1978), limited empirical support of assessments -- particularly with respect to representative observations for inter-city travel.

Based on limited empirical data, and information from user studies and survey results, qualitative evaluations were developed. A model-building approach is employed in the NTPSC paper, whereas in the research by the Economic Research Centre, both a statistical review of telecommunications and transportation development and an analysis of communication behavior and effectiveness of teleconferencing in comparison with natural face-to-face conversation are conducted. Tealeb and Orton, on the other hand, discuss the cost differential between both modes and its development in favor of telecommunications.

The study by the NTPSC distinguishes between substitutability (upper bound of substitution) and substitution (actual amount) since, in some cases, people can evaluate certain forms of business communications actually involving travel as

substitutable through teleconferencing, but finally -- when faced with the choice between both modes -- would have personal preferences for travel.

The Economic Research Centre addresses the lack of empirical data, as well as the fact that most projections are based on a given technological environment as the main deficiencies of existing research. Technology transfers would be neither immediate, nor completed.

Objectives	<ul style="list-style-type: none"> ➤ Identification of significant trends and driving factors in telecommunications / transportation interaction; inter-city travel as part of a more general discussion of issue. ➤ Addressing transportation planning policies and models; also integration of macroeconomic aspects, as industrial location patterns and organizational structures, as consequence of telecommunications, and their impact on transportation; potential of energy conservation as result of travel substitution.
Approach	<ul style="list-style-type: none"> ➤ Discussion and analysis of existing research; addressing economic and psychological conditions for substitution based on review of existing research; interpretation of survey results. ➤ Addressing communication behavior and effectiveness of teleconferencing forms for specific business applications. ➤ Statistical review of growth of both modes.
Results	<p>Related to inter-city travel:</p> <ul style="list-style-type: none"> ➤ Recognition of limitations of existing approaches: Substitution estimates for future based on given technological and economical environment; need for more empirical research to recognize specific user preferences, adoption patterns, acceptance, etc.; insufficient knowledge of breakdown of teleconferencing and business trips by purpose. ➤ Teleconferencing -- even less sophisticated forms -- rather effective to meet business meeting needs; the degree of user satisfaction depends on the greater or lesser complexity of the communication. ➤ Based on existing studies, survey results, and user assessments, estimation of substitution potential for business travel of 20-25% (rail plus air); substitutability (theoretical maximum) of 35-70%.
Judgment	<ul style="list-style-type: none"> ➤ Bias: Concentration on substitution, neglecting stimulation, travel modification, and other more complex interactions. ➤ Deficiencies: Lack of empirical support, very subjective assessments, time of study (videoconferencing and other multimedia technologies far less developed and accepted than today), most "real world" observations used to support argumentation focused on regional and urban scope (telecommuting). ➤ Some interesting discussions of communication behavioral aspects; however, with respect to technological level at this time only partially applicable to today's discussion.

On the basis of existing studies and survey results, the substitutability of inter-city business travel is stated as being between 35% and 80%, while the average substitution observed -- on project basis -- would be between 20% and 40%.

Objectives	<ul style="list-style-type: none"> ➤ Overview of changes occurring in telecommunications area and suggestion of some implications for urban and regional development, especially in transportation area; including macroeconomic considerations, e.g., with respect to energy consumption and savings. ➤ Inter-city travel also part of analysis, looking at teleconferencing versus business travel, especially by air.
Approach	<ul style="list-style-type: none"> ➤ Analyzing developments in telecommunications area; referring to exemplary cases; discussing observations with respect to telecommunications projects and implementations. ➤ Qualitative assessment of existing research and empirical observations; simple cost analysis.
Results	<p>Related to inter-city travel:</p> <ul style="list-style-type: none"> ➤ Identification of notable substitution potential for travel by modern teleconferencing applications, not only by videoconferencing but also by more conventional audio teleconferencing systems. ➤ On the basis of studies, surveys, and exemplary observations in "real world", identification of substitution potential ranging from 20-80% on project basis, depending on various factors, such as company, business activities involved, or geographical scope; usually significant savings in travel expenses and very short payback periods (often only several months).
Judgment	<ul style="list-style-type: none"> ➤ Bias: Focus on substitution and project-basis, neglecting more complex and far-reaching relationships associated with stimulation and modification of travel. ➤ Deficiencies: Insufficient empirical support, highly speculative evaluations, time of study (technological standard, costs, accessibility, acceptance, experience of users, etc.).

All three studies suffer the inherent bias that they exclusively examine the negative impact (substitution) of telecommunications on transportation. Stimulation is not addressed. Substitution, on the other hand, is primarily analyzed on a project basis (exemplary cases), neglecting the long-term indirect relationships between both modes, which are normally of a wider scope than the project-based substitution impact.

A further limit for today's application of these studies is the time of their execution. The discussion is based on a technological level for videoconferencing that is not comparable with today's level. In addition, costs, accessibility, network connectivity, adoption patterns, and acceptance of modern teleconferencing have dramatically changed.

With respect to the study of the Economic Research Centre, it should be considered that the results of a specific French research in 1980 discussed in this study are employed in a 1991 study of Arthur D. Little (see later) for estimating today's and future inter-city business air travel substitution potential in the U.S. Not only are time and regional aspects divergent but also the environment, since the French study focused on regional and urban transportation (telecommuting).

An interesting part of the paper by the Economic Research Centre is the discussion of communication behavioral aspects and the analysis of user evaluations regarding the effectiveness of teleconferencing for activities normally taking place in a business meeting, showing rather positive ratings even for conventional audioconferencing. Question 6d in the videoconferencing user questionnaire designed for this thesis (see Appendix 2 and discussion in 3.7) is basically derived from this discussion and its survey.

Study by Schuler (2/1992); Table 4.2.2.1-4

Although the study by Schuler focuses on urban infrastructure, the theoretical discussion of the fundamental attributes of transportation and telecommunications systems and their interrelationships, and primarily the mathematical modeling of telecommunications-travel demand interactions with respect to price-income sensitivity are useful for the discussion of the issue of teleconferencing versus business air travel.

The prime aspect of the analytical approach is the impact of cost and time on the preference of an individual for one of the two modes (marginal rate of substitution between number of trips and telecommunications usage). The basic result of this analysis (see also Table 4.2.2.1-4) is that an individual with higher marginal values of time (income) places heavier reliance on telecommunications, particularly for interactions of short duration over long distances. This result also confirms trends recognized in cost-benefit analysis in section 4.3. However, these analytical relations need to be calibrated and validated with more empirical data.

The focus on cost and time neglects several other factors underlying the choice of the communications medium for certain meeting purposes (see section 3.8 and 4.1.2) and often perceived as more important than the mere cost trade-off. Along with the studies discussed previously, Schuler's approach also has the bias that it assumes a competitive relationship between telecommunications and transportation and neglects any complementary effects.

Table 4.2.2.1-4: Study by Schuler (2/1992)	
Objectives	<ul style="list-style-type: none"> ➤ Development of mathematical/analytical model of price-income sensitivity underlying choice of telecommunications and transportation; focus on urban infrastructure; however, qualitative modeling approach also useful for issue of inter-city travel. ➤ Addressing of patterns of cost recovery and pricing, urban spatial patterns, and demand for infrastructure investment in both areas telecommunications and transportation.
Approach	<ul style="list-style-type: none"> ➤ Identification and discussion of fundamental attributes of transportation and telecommunications systems, particularly cost and demand. ➤ Analytical model of impact of cost and time structures on relative demand for telecommunications and transportation → marginal rate of substitution of transportation by telecommunications.
Results	<ul style="list-style-type: none"> ➤ Results of price-income sensitivity mode-choice model: <ul style="list-style-type: none"> ✧ Nearby interactions (short-distance): <p><i>Interactions of short duration:</i></p> <p>For low-income groups, the cost of using telecommunications dominates versus the cost of a personal visit involving travel; here personal visits may be preferred. For high-income groups, the unit time cost dominates, leading to a preference of using telecommunications.</p> <p><i>Interactions of long duration:</i></p> <p>For low-income groups, all contacts will be by personal visit. For high-income groups, the choice of meeting form will depend on the shape of the value function representing the value of personal contact of an individual. However, compared with nearby interactions, the relative favorability of travel increases.</p> ✧ Long-distance interactions: <p>The higher the income, the greater the proportion of contacts that will be made by telecommunications. The longer the required average duration of contacts, the larger the proportion that will be accomplished by travel and personal contacts.</p>
Judgment	<ul style="list-style-type: none"> ➤ Interesting analytical modeling approach; however, need for calibration and empirical validation. ➤ By focusing on cost and time as attributes determining the choice of communications mode, neglecting all other factors underlying such a decision, e.g., social, psychological and communicational effectiveness of media for certain types of business meeting.

Study by Salomon and Schofer (3/1988); Table 4.2.2.1-5

As opposed to the previous studies, Salomon and Schofer consider the potential stimulation effect of enhanced telecommunications on inter-city business travel demand in their analysis, which is focused on the identification of relevant factors

underlying the telecommunications-transportation interaction and the addressing of problems of forecasting these interactions.

Objectives	<ul style="list-style-type: none"> ➤ Identification of telecommunications impacts that may positively or negatively affect inter-city transportation demand: "What telecommunications impacts are relevant to transportation?"; "What factors may affect these changes?" ➤ Discussion of the problems of forecasting telecommunications / transportation interactions. ➤ Identification of future research opportunities.
Approach	<ul style="list-style-type: none"> ➤ Review and analysis of existing research. ➤ Discussion of factors underlying penetration and adoption of telecommunications technologies; analysis of long-run impacts of telecommunications services on transportation -- also addressing spatial and organizational factors.
Results	<ul style="list-style-type: none"> ➤ The more dispersed the interactions, the greater the potential benefits of teleconferencing for a firm; the strong trend toward multi-location firms and the globalization of business may therefore augment teleconferencing market. ➤ However, teleconferencing has also limits and cannot fulfill certain important business communication needs; teleconferencing is not likely to significantly replace travel. ➤ Teleconferencing might substitute for some forms of travel, particularly internal to company; however, since it facilitates the trend toward globalization of business and generates new business opportunities, there is a strong possibility that advanced teleconferencing technologies stimulate more travel than they substitute in a short-term perspective. ➤ Impacts on travel depend on geographical distribution of participants, the nature and length of communications, and the prevailing travel and telecommunications costs. ➤ Lack of empirical data for reliable modeling approaches is apparent; therefore, current research relies heavily on judgmental forecasts; strong need for empirical research and behavioral studies to identify mode-choice characteristics.
Judgment	<ul style="list-style-type: none"> ➤ Very fruitful discussion of theoretical relationships, dependencies, and sensitivities characterizing telecommunications-transportation interactions; addressing not only substitution but also travel stimulation and modification.

Also this study contains a review and qualitative discussion of prior research. Problems in forecasting the telecommunications impact on travel are addressed through analyzing current approaches. It is emphasized that those are lacking reliable empirical foundation and are not based on mathematical demand models, which would represent the most widely accepted and most desirable approaches.

The study also looked at long-run impacts and the significance of spatial and organizational structure of a firm for the degree to which a company can benefit from teleconferencing. The research concluded that the more dispersed the inter-

actions are, the greater the potential benefits. The trend toward multi-locational firms and the globalization of business may augment the market potential for teleconferencing.

However, Salomon and Schofer also recognized limits for teleconferencing applications and address that for certain important functions, teleconferencing is not likely to replace travel. Limits in communications effectiveness, as well as secondary incentives and personal preferences of traveling were given as reasons.

According to the study, teleconferencing might well substitute for some travel. However, since telecommunications would facilitate the trend toward globalization and stimulate communications as a whole, Salomon and Schofer see a strong probability that teleconferencing will also promote more travel. The complementary effects on travel would finally at least offset any short-term substitution, according to their judgment.

The paper contains a very fruitful discussion considering both substitution and stimulation, as well as long-term effects associated with spatial and organizational characteristics of businesses and with the globalization of cooperation and competition.

Study by Egido (1988); Table 4.2.2.1-6

Egido focuses on videoconferencing as a face-to-face substitute and tries to identify the reasons behind the failure and low acceptance of the technology at the time of the study (1988). It must be understood that 1988 is just the beginning of the real breakthrough of videoconferencing in the business world and, therefore, certain arguments in the paper are in need of re-examination and validation under meanwhile changed circumstances in terms of technology, costs, availability, and acceptance.

Egido sees videoconferencing not as substitute for natural face-to-face meetings and, therefore, not as replacement for business travel. Examining the "before and after" travel patterns of teleconferencing, users would show an increase in the number of in-person meetings and trips rather than a decline. Even, if existing research claims a higher communication effectiveness and efficiency of videoconferencing compared with in-person meetings, especially through the reduction of time wasted with small talk, the importance of informal, unofficial interactions in business meetings must be considered. These are not possible in videoconferences.

According to Egido, there is much evidence that it is often these informal chats outside the official meeting rooms where important information is transmitted and real decisions are made.

Objectives	➤ Analysis of reasons behind the failure of videoconferencing (by 1988); discussion of likely ways to a success of this technology and of factors that might further influence the acceptance and market penetration of videoconferencing.
Approach	➤ Review and analysis of existing teleconferencing literature and exemplary case studies.
Results	<ul style="list-style-type: none"> ➤ Teleconferencing should not be regarded as direct replacement for face-to-face meetings; examining the "before and after" travel patterns of teleconferencing users suggests not a substitution of travel, but rather an increase in the number of natural face-to-face meetings involving traveling; complementary relationship between videoconferencing and business travel. ➤ Although existing research widely supports the effectiveness of teleconferencing for various meeting purposes, several psychological aspects and secondary incentives of travel must be considered, e.g., reduced opportunity in teleconferencing meetings for informal, unofficial conversation, which is often essential for information transmission and real decision-making. ➤ Reasons for overall failure of videoconferencing revolve around its misrepresentation as a substitute for in-person meetings and the current (at 1988) lack of real utility of video capability; however, structural changes in the nature of managerial hierarchies may broaden the market for teleconferencing.
Judgment	➤ Paper critically analyzes the widely supported theory of travel substitution; however, since 1988, videoconferencing has significantly developed in terms of technology, cost, market penetration and adoption, and acceptance → qualitative assessments need re-examination and validation.

Contrary to the main body of current literature in this field, the paper critically analyzes the widely supported theory of travel substitution and contributes some interesting argument to the hypothesis of a complementary relationship between telecommunications and business travel. Nevertheless, the study also recognizes that factors such as the increasing technical orientation of businesses, the proliferation of office automation technology, and structural changes in the nature of managerial hierarchies may broaden the market for videoconferencing.

Study by Bennison (4/1988); Table 4.2.2.1-7

Bennison studied user reactions, preferences and characteristics in a videoconferencing field trial in the United Kingdom, involving 14 major UK companies as participants. However, the fact that videoconferencing only became established in

three of these companies, while an initial period of experimentation in the other 11 firms never developed into any pattern of regular use, may limit the validity of this more empirical approach.

Objectives	<ul style="list-style-type: none"> ➤ Description and interpretation of user reactions in a videoconferencing field trial in the United Kingdom. ➤ Provision of empirical evidence for interactions between transportation and telecommunications.
Approach	<ul style="list-style-type: none"> ➤ Surveying user characteristics, preferences and assessments in a videoconferencing field trial in the United Kingdom from 1983-86 involving 14 major companies; however, only in three companies, videoconferencing became established, while in the other 11 corporations, an initial period of examination of videoconferencing never developed into any pattern of regular use → very limited empirical sample size.
Results	<ul style="list-style-type: none"> ➤ Results of field trial support that videoconferencing is primarily a complement to travel; only marginal substitution, which is normally offset by generation of new business needs through videoconferencing. ➤ Videoconferencing often an upgrading of conventional telecommunications means. ➤ Videoconferencing generates its own communication demand → telecommunications media cannot be regarded as another form of transport.
Judgment	<ul style="list-style-type: none"> ➤ Paper provides an interesting discussion of basic factors and characteristics underlying relationship between telecommunications and travel. ➤ However, the limited sample size, as well as the low level of established videoconferencing applications in companies surveyed does not provide a strong empirical basis for argumentation in favor of complementary relationship of teleconferencing and business travel; also, time of field trial -- mid 1980s -- limits applicability of findings to present research.

Based on the field trial and previous research findings, Bennison concludes that - although some substitution of business travel can be observed in companies using videoconferencing -- telecommunications cannot be regarded as another transportation mode and that the relationship between videoconferencing and travel is not sufficiently expressed through a simple trade-off model. He concludes that videoconferencing complements conventional face-to-face meetings rather than replaces them.

The limited sample size and the low level of established videoconferencing systems in the companies surveyed do not provide valid empirical evidence for any hypothesis regarding the telecommunications-transportation interaction. Nevertheless, the qualitative discussion and interpretation of survey results and existing

research provide interesting arguments in favor of the theory of a complementary relationship between telecommunications and travel. However, again, it has to be considered that the analysis and empirical findings are based on a technology and market adoption and acceptance at the end of the 1980s.

Study by Mokhtarian (3/1990); Table 4.2.2.1-8

In her paper intending to define the relationship between telecommunications and transportation, Mokhtarian suggests the complementary interaction between both modes. She looks at the evolution and characteristics of both telecommunications and transportation, discusses parallels between them, and puts relationships identified in earlier research into an economic framework of supply and demand.

Empirical research is used as the basis and evidence for the theory of complementary interaction. And, although relying on empirical proof from studies performed on a more regional and urban basis, qualitative findings regarding user preferences, characteristics, and impact on travel needs are applicable to the issue of this thesis.

Mokhtarian suggests a theory of simultaneous substitution and stimulation of communications modes by enhanced teleconferencing systems, which might lead in absolute terms to an increase of physical face-to-face meetings involving travel (see discussion in section 4.1.2.2). Mokhtarian sets forth that the most important impact of telecommunications on travel may not be that it increases or decreases the amount of travel, but that it provides a great deal more flexibility in whether, when, where, and how to travel ("travel shifting"). Modern telecommunications relax the constraint of having to be at a certain place at a certain time.

With reference to earlier research by Mokhtarian (4/1988: 283), the concept of constant personal travel time budget is addressed (see Table 4.2.2.1-8). Furthermore, Mokhtarian (1988: 264) suggests that there may be purposes for traveling that are secondary to the supposed reason for a trip, but nevertheless important. Travel could be a fringe benefit, a sign of status, or simply a welcome break from the office routine. Frequent trips -- primarily internal to company -- that are actually eliminated by enhanced teleconferencing may be simply replaced by other, more desirable trips, which were not possible before due to time constraints.

Table 4.2.2.1-8: Study by Mokhtarian (3/1990)	
Objectives	<ul style="list-style-type: none"> ➤ Definition of relationship between telecommunications and transportation by expanding the linkages already identified in previous research, by identifying additional relationships, and by putting these relationships into a robust conceptual framework. ➤ Provision of a broader, more complete understanding of relationship between telecommunications and transportation, considering both substitution and stimulation.
Approach	<ul style="list-style-type: none"> ➤ Analysis and discussion of evolution and characteristics of both modes; addressing parallels (conceptual, physical, analytical, and regulatory). ➤ Putting relationships identified in earlier research into an economic framework of supply and demand. ➤ Analyzing empirical studies and field trials focusing on business travel versus teleconferencing (see Mokhtarian 4/1988); although primarily conducted on regional and urban basis, qualitative findings are also applicable to inter-city travel problem.
Results	<ul style="list-style-type: none"> ➤ Recognition of complementary relationship; by making information about outside activities and interaction opportunities accessible, telecommunications create the desire of physical movement, thereby stimulating travel. ➤ Theory of simultaneous substitution and stimulation of travel; overall, the more one form of communications takes place, the more communications as a whole are stimulated; relative share of travel of total communications will decline as result of teleconferencing but increase in absolute terms; frequent trips actually eliminated by teleconferencing are replaced by other trips. ➤ Most important impact of telecommunications not substitution or stimulation of travel, but increase in flexibility whether, when, where, and how to travel. ➤ Based on 1988 paper (Mokhtarian 4/1988), addressing of concept of constant personal travel time budget; under this paradigm, the natural result of reducing some travel by whatever means is that additional travel will be created to compensate (or fulfill) the travel time budget; telecommunications do not directly stimulate travel, in this case, but simply offer an alternative to reduce travel and, thereby, free time for increased business and associated travel for other purposes. ➤ Importance of secondary incentives of travel; business travel can be a benefit or a sign of status, or simply a welcome break from the office routine -- particularly in international area, when destination is of cultural, social and/or recreational attraction.
Judgment	<ul style="list-style-type: none"> ➤ Study addresses -- opposed to most other approaches in this field -- complementary relationship of teleconferencing and business travel and other rather complex interactions and provides interesting and reasonable argumentation; valuable contribution to the hypothesis of travel stimulation and modification as results of teleconferencing. ➤ However, despite the provision of some empirical evidence (mostly on project-basis with regional scope of telecommunications-travel interactions), highly qualitative; perhaps even neglecting substitution potential of teleconferencing for business travel.

The paper provides a rather convincing and valuable argument supporting the theory of a complementary relationship between telecommunications and business travel. However, in spite of references to empirical examinations and experience, the paper is still highly qualitative and perhaps even neglects the substitution potential of teleconferencing for various business trips.

Study by Erdal and Hallingby (1992); Table 4.2.2.1-9

The study by Erdal and Hallingby addresses the issue of the impact of teleconferencing on business travel by focusing on developments during the Gulf War. The analysis is based on statistics of telecommunications and international air travel, as well as on surveys among business air travelers and companies engaged in international business relations. The study focuses on Norway.

Erdal and Hallingby conclude that the overall substitution impact of telecommunications on travel is marginal and that telecommunications have a complementary function in the total communications pattern in a company. This theory is empirically supported, primarily by observations made during the Gulf War. The study addresses the significance of social aspects in business travel where there is a need for first contact and which is important to retain the engagement. Within a company, visiting each other means keeping and developing company culture and relationships for employees.

However, in spite of some interesting theoretical arguments, the empirical support is lacking. At the time of the Gulf War, the international business videoconferencing infrastructure was just in its initial development, particularly in Europe. The accessibility was limited, and even if a videoconferencing system was conveniently available for one party, such an access usually did not exist for other parties involved in the specific business. According to Salomon and Schofer (3/1988: 221), a unique feature of telecommunications adoption is the importance of the size and degree of connectedness of the network; that is, the number and nature of servers and other users with which connections can be established. This is crucial to its rate of adoption.

The marginal substitution of business travel canceled during the Gulf War by teleconferencing does not provide sufficient support for the complementary interaction between both modes. The Gulf crisis and its effect on international aviation caused companies to turn more attention to videoconferencing. Businesses gained their first experiences with this technology and recognized its effectiveness

and convenience of use, which then became a basis for subsequent increasing adoption to videoconferencing.

Objectives	<ul style="list-style-type: none"> ➤ Better understanding of relationship between enhanced telecommunications and travel, interesting from theoretical point of view and from perspective of future demands for capacity in international telecommunications networks.
Approach	<ul style="list-style-type: none"> ➤ Focusing on telecommunications-business travel relationship during Gulf War in case of business activities of Norwegian companies. ➤ Statistical analysis of public telecommunications between Norway and selected countries where Norwegian companies do business; statistical analysis of passengers on international flights to and from Norway. ➤ Surveys among international business passengers at Oslo airport during Gulf War; interviews with Norwegian companies engaged in international business activities.
Results	<ul style="list-style-type: none"> ➤ On the basis of statistical analyses and surveys, finding that substitution effect between telecommunications and business travel is marginal, even during crises like the Gulf War. ➤ Confirmation of existence of complementary relationship between telecommunications and business travel. ➤ Utilization of new telecommunication technologies has far-reaching consequences on the structural organization of production and labor and, therefore, on the origins of demand for business travel and communications as a whole; importance of social aspects involved in business travel for mode-choice.
Judgment	<ul style="list-style-type: none"> ➤ In spite of some reasonable argumentation and discussion, the empirical and statistical support of hypothesis of a complementary relationship of telecommunications and transportation is lacking; teleconferencing adoption during the Gulf War is not a sufficient indicator; at this time, accessibility and connectedness of the network were limited, especially in Europe, constraining an immediate adoption to videoconferencing and other enhanced teleconferencing media as replacement for canceled business trips; complex relationship of teleconferencing and business travel with several long-term and indirect interactions cannot be sufficiently supported by observations made during the Gulf War. ➤ Neglecting importance of Gulf crisis for breakthrough of videoconferencing; particularly in the U.S., businesses gained first experiences with videoconferencing during Gulf War and recognized its effectiveness and convenience.

The significance of the Gulf War for the market penetration of videoconferencing and for its role as competitor of certain forms of business travel is probably understated.

Study by Khan (1987); Table 4.2.2.1-10

Contrary to most of the prior studies of this section, the research by Khan specifically addresses air travel and how it might be affected by enhanced tele-

communications as main study objective. The study highlights findings on the determinants of travel substitution and stimulation and provides estimates for both impacts. The study is based on a 4-step methodological framework (see "Approach" in Table 4.2.2.1-10).

Objectives	<ul style="list-style-type: none"> ➤ Highlighting of findings on the determinants of travel substitution and stimulation phenomena; provision of estimates for substitution and stimulation of travel by enhanced telecommunications. ➤ Improving scientific basis for developing estimates of replaced travel and associated impacts, such as transportation infrastructure.
Approach	<ul style="list-style-type: none"> ➤ Four-step methodology: (1) identification of major socio-technical factors underlying relationship of telecommunications and transportation, (2) investigation of influence and interrelationships of these variables, (3) Assessment of experience gained through surveys, demonstrations, and user observations, and (4) examination of trade-offs and travel impacts. ➤ Quantification of substitution and stimulation potential on basis of existing surveys and field trials. ➤ Simplified cost model for analysis of cost differential of both modes.
Results	<ul style="list-style-type: none"> ➤ Teleconferencing is assessed to fulfill a wide range of business meeting purposes (40-60%); with improving technology and price performance, increasing acceptance and preference in business world expected. ➤ Recognition of significant lacks in existing research, particularly with respect to empirical data and formal models. ➤ Upper limit of substitution potential of business air travel seen at 20%-25%; quantification of maximum stimulation with 2% of base level; correction of both values (reduction by factor 2 [50%]) due to limited reliability of attitudinal survey data → upper net impact expected (balance of substituted and stimulated trips): about 10% substitution of business air travel; growth of replaced travel is expected to take an S-shape profile; travel replacement is likely to take up to two decades to reach its potential.
Judgment	<ul style="list-style-type: none"> ➤ Basic qualitative discussion interesting and valuable. ➤ Quantifications of telecommunications impact on travel not sufficiently supported through convincing empirical findings (time, environment, circumstances, level of experience, etc.); observations of substitution effects mainly on project basis; capability to measure and quantify stimulation potential questionable. ➤ Overall impact on travel of company more complex than balance of substitution and stimulation; both occur on different time horizons (substitution more short-term and direct, while stimulation more long-term and indirect) and involve trips of different frequency (substitution of frequent trips), duration, geographical scope, and motivation (substitution of trips internal to company, generation of travel for inter-company meeting purposes).

Khan identifies communication needs that are substitutable by teleconferencing, ranging from information exchange, exploratory communication and planning, to

crisis decision-making and various administrative activities. Khan recognizes uncertainties and deficiencies in prior research, particularly with respect to empirical knowledge and analytical modeling, and introduces a simple cost model, showing the continuous improvement of the price performance of videoconferencing relative to air travel as function of time.

On the basis of existing research -- field trials and attitudinal surveys, he estimates an upper limit of travel substitution (substitutability) of 20%-25% and a maximum level of stimulation, occurring at the same time, of around 2%. Since attitudinal survey results normally overstate the "real world", Khan subjectively corrects these estimates by a factor of 2 (50%), and, finally, projects an overall substitution potential of 10% for business air travel by enhanced telecommunications.

The growth of replaced travel is expected by Khan to take an S-shaped profile due to the profiles of cost differentials and market penetration of teleconference systems. The process until reaching the total substitution potential is expected to take up to two decades, being subject to future technology and cost trends, as well as to marketing and promotion efforts of both sides telecommunications and airline industry.

However, the validity of these estimates for today's discussion is suspect due to the time of the study, but also to the way they were determined. The estimates for substitutability were averaged from various existing survey results, which were based on different environments and circumstances (project-based, site-based, etc.). Furthermore, the possibility of a reliable quantification of stimulation can be questioned with respect to its complex nature (see section 4.1.2.2). Although substitution and stimulation occur simultaneously, a simple subtraction of both estimates does not seem to be justifiable since different types of business trips (frequency, duration, regional, motivation) are involved. Substitution is more direct and observable in the short-term, while stimulation is often more indirect with a long-term perspective.

4.2.2.2 Studies That Develop Quantified Forecasts and Estimates

Although the discussion in section 4.2.2.1 contained studies providing quantified estimates and forecasts for the telecommunications impact on business travel, those assessments were based primarily on a review of other research results and were not systematically derived. The discussion of more theoretical and

qualitative interactions and characteristics has been the prime motivation of those studies.

The following studies were intended to provide quantifications of the impact of modern teleconferencing technologies on business air travel. They have been done primarily in commission of clients who are interested in such projections. However, as shown subsequently, this does not imply that these research works are free of judgmental assessments. Subjective and speculative estimates for the telecommunications-travel interaction are also important ingredients in these studies. Three of the four subsequently analyzed studies have received the attention by the airline industry in recent months: the 1993 Logan airport study by Arthur D. Little, the study by The Arvai Group (1994), a consultant in Windham, New Hampshire, and the research by Apogee Research (1994), a consulting firm in Bethesda, Maryland, in commission by the FAA.

Study by Arthur D. Little (1991); Table 4.2.2.2-1

Before discussing the latter three studies, a work by Arthur D. Little from 1991 should be addressed. This study serves as basis for certain assumptions and estimates of Arthur D. Little's Logan airport study in 1993.

The purpose of the 1991 study was the analysis of the potential role of telecommunications in solving U.S. transportation problems, through an attempt to quantify in monetary terms the benefits from the substitution of different transportation modes by means of modern telecommunications. Thereby, economic and transportation policies, as well as energy savings and environmental benefits are assessed. In spite of this rather general objective, the study specifically analyzes the interaction of teleconferencing and business air travel and systematically derives estimates for the impact on travel -- in the form of trip substitution. This exclusive focus on substitution undoubtedly represents a heavy bias since stimulation and other more complex interactions are completely neglected.

The study analyzes the impact on business travel in a disaggregated way, distinguishing between business trips by car and air. It further subdivides the latter trip category by travel purpose, based on the breakdown of trips provided by the U.S. Data Center (see section 2.1.2). For each of these categories, coefficients of substitution are estimated (see Table 4.2.2.2-1).

However, these estimates assigned to each trip purpose are lacking empirical support. They are based on data from a French study of 1980 (Economic Research Centre 1983: 36/37) that comes from a quite different context. In this study, theoretical maximum coefficients of substitution are estimated for working at home (telecommuting; 13% substitution on an optimistic assumption, and 23% on a very optimistic assumption).

Table 4.2.2.2-1: Study by Arthur D. Little (1991)	
Objectives	<ul style="list-style-type: none"> ➤ Analysis of telecommunications' potential role in solving U.S. transportation problems; provision of independent, objective, transportation-oriented quantification of benefits from substituting transportation (air, rail, car) by modern telecommunications means. ➤ Specifically addressing impact of teleconferencing on business trips (air, car).
Approach	<p>Related to teleconferencing versus business travel</p> <ul style="list-style-type: none"> ➤ Disaggregated analysis of impact on business trips by car and air; further differentiation by purpose of trips (based on categorization and data of U.S. Travel Data Center (see section 2.1.2)); assigning of coefficients of substitution to each of these categories in order to receive estimate of overall impact on business air travel (percentage substitution, number of annual trips substitutable, etc.).
Results	<p>Related to teleconferencing versus business travel:</p> <ul style="list-style-type: none"> ➤ Coefficients of substitution for business air trip purposes: intra-company: 23%, inter-company: 13%, conferences: 0%, training: 13%, other meetings: 0%; based on French study of 1980 that estimated theoretical maximum coefficients of substitution (13-23%) for working at home (telecommuting) !!!; these coefficients are then subjectively assigned to travel categories. ➤ Total substitution potential of business air travel in U.S. by teleconferencing: about 8%, representing 5.6 million business trips, and 45 million hours business travel time at traffic levels of 1988.
Judgment	<ul style="list-style-type: none"> ➤ Bias: Concentration on mere substitution trade-off, full neglecting of stimulation and other more complex and indirect interactions between enhanced telecommunications, business structure and activities, and travel needs; no addressing of time needed to reach this estimated substitution potential -- only assumption that fiber optic network is fully developed (100% penetration) when full potential is reached. ➤ Empirical support of estimate for substitution potential of today's U.S. business air travel is heavily lacking due to origin of coefficients of substitution (1980, France, regional/urban basis) and the subjective assignment of these values to trip categories; therefore, this quantification of substitution potential is not valuable for today's professional discussion of research issue.

With respect to time (1980), and environment (France; regional and urban), the application of these coefficients to today's and future inter-city air travel in the U.S. is more than questionable. In addition, these substitution estimates (13-23%) are

somehow subjectively assigned to each trip category under the assumption of a fully developed fiber optic network for the U.S. (100% penetration). Due to this significant methodological weakness, the value of 8% substitution of U.S. business air travel (5.6 million U.S. business air trips per year with respect to data of 1988), which result from applying the substitution coefficients to the percentage share of each trip purpose of total business air travel, is very suspect.

In addition, the complete neglect of complementary relationships between telecommunications and travel is a significant deficiency of this approach as already been stated. Nevertheless, in spite of these limitations, this approach became the basis for the analysis of the telecommunications impact on air travel for the 1993 Logan airport study by Arthur D. Little.

Study by Arthur D. Little (1993); Table 4.2.2.2-2

The Logan airport study by Arthur D. Little was a \$627,000 project financed to 90% by the FAA. The study's objective was the forecast of demand, and, consequently, the need for capacity (e.g., new airport, expansion of Logan International) for inter-city transport (high-speed rail, air) in the Boston area throughout the year 2030. In the various scenarios analyzed for this purpose, telecommunications, particularly videoconferencing, were assessed as substitute mode for air travel.

For this study, air travel demand was segmented into discretionary (pleasure) and non-discretionary (business) travel. The advantages of videoconferencing for pleasure travelers are evaluated as less compelling, and substitution coefficients are, consequently, rather marginal. A further subdivision of both types of travel is made by domestic and international travel and by stage length.

The classification of business travelers by trip purpose is based on Arthur D. Little's 1991 study and, therefore, the U.S. Travel Data Center's survey data (see section 2.1.2). The substitution coefficients for each trip category do not equal those in the 1991 study. However, the basic structure is undoubtedly derived from this source (see Table 4.2.2.2-2), which, as stated previously, lacks convincing empirical support. Though the coefficients of the 1991 research are basically modified upward following a consistent, but very qualitative pattern (0%→5%; 13%→15%; 23%→30%), access to proprietary data of companies using videoconferencing and reports of experienced users are claimed to have been integrated

into these estimates (Todd Burger, consultant at Arthur D. Little, responsible for Logan study: interview with author).

Objectives	<ul style="list-style-type: none"> ➤ Forecasting demand and capacity need for inter-city high-speed transport in the Boston region through the year 2030; examination of need for second airport or expansion of Logan airport. ➤ Investigation of substitute modes for air travel: rail and telecommunications; estimation of impact of enhanced telecommunications, especially videoconferencing, on demand for air travel.
Approach	<p>Related to analysis of telecommunications impact on air travel:</p> <ul style="list-style-type: none"> ➤ Segmentation of air travel demand by type of travel in discretionary and non-discretionary demand; classification of non-discretionary demand by trip purpose and assignment of percentage share of total U.S. business travel to each category (taken from U.S. Travel Data Center, 1988; see section 2.1.2); further segmentation by stage length and domestic/international travel. ➤ Estimation of substitution rates for each category; these estimates are clearly related to estimates in 1991 study of Arthur D. Little, which are based on French study of 1980 that estimated theoretical maximum coefficients of substitution (13-23%) for working at home (telecommuting) !!!; coefficients are slightly modified (upward), but basic pattern of 1991 study significant; however, according to Arthur D. Little, substitution estimates are primarily based on corporate experience (access to proprietary data of companies substituting air travel by videoconferencing, survey results, interviews with users); nevertheless, very weakly and highly speculative basis of substitution estimates. ➤ Development of substitution estimates by stage length and domestic / international, very qualitative.
Results	<p>Related to analysis of telecommunications impact on air travel:</p> <ul style="list-style-type: none"> ➤ Telecommunications effect by type of business trip (substitution coefficients): 30% intra-company, 15% inter-company, 5% conferences, 15% training, 5% other (compare with Arthur D. Little's 1991 study → slight upward correction of estimates); on this basis, overall substitution potential of 14% for U.S. business air travel (nationwide applicable; considering sensitivity: 12-16%). ➤ Based on this estimate, rough assumption of substitution impact on stage length and type of traveler: domestic discretionary: 2% (short-haul) - 8% (long-haul); international discretionary: 0%; domestic non-discretionary: short-haul 16%, medium-haul 25%, long-haul 38%; international non-discretionary: 20%. ➤ Application of these figures to projected traffic and its composition for Boston leads to 7.3% air travel substitution (2.5 million air trips) by videoconferencing in 2010 and 15.2% (7.2 million air trips) in 2030.

Table 4.2.2.2-2 (Cont'd): Study by Arthur D. Little (1993)

<i>Judgment</i>	<ul style="list-style-type: none"> ➤ Bias: Concentration on substitution, neglecting complementary interactions between telecommunications and travel; it is expected that time savings due to use of videoconferencing for certain projects do not free time for other business activities generating new travel, but for streamlining organizations. ➤ Support of substitution estimates is heavily lacking; relying on Arthur D. Little's 1991 study data and, therefore, on French study conducted in urban environment in 1980 → questionable basis for projections of U.S. air travel in 2010 and 2030, respectively !!! -- although also corporate experience and data are given as sources for these figures, very speculative assumptions; highly disaggregated analysis of substitution by stage length and domestic/international with respect to these uncertainties not justifiable.
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By applying the substitution coefficients to the percentage shares of each individual trip category of total U.S. business air travel (U.S. Data Center; see section 2.1.2), an overall substitution potential for U.S. business air travel of 14% has been determined. The time horizon by which this might be reached is estimated to be by the year 2030. On a world-wide basis, the level of potential substitution of business air travel is expected to be slightly lower (8-12%; Hughes November 29, 1993: 39).

On the basis of this 14%-estimation, qualitative projections are made with respect to type of traveler (pleasure/business), stage length, and domestic/international. However, these quantifications are not sufficiently supported in the final report of Arthur D. Little. For business air travel, the substitution estimates range from 16% for short-haul domestic travel to 38% in the long-haul area. U.S. international business air travel is expected to experience a substitution of around 20% by modern telecommunications. However, considering that the 14%-substitution are based on business air travel (see above), the fact that all the above estimates exceed this figure arouses questions as to how they could be achieved.

These estimates are applied to projected traffic data and travel composition for Logan airport in 2010 and 2030, leading to the forecast of a substitution of 7.3% (2.5 million air trips) by videoconferencing for air travel at Boston in 2010, and 15.2% substitution (7.2 million air trips) in 2030.

Like many studies, this approach does not address the stimulation potential and other complex interactions discussed in section 4.1, although it is claimed that substitution projections are adjusted for any possible travel generation due to videoconferencing usage. Arthur D. Little expects that productivity and efficiency gains,

particularly through time savings, are used to streamline organizations and workforces rather than generating more business trips for the whole community.

The largest limitation of this approach to quantify the impact of telecommunications on business air travel is undoubtedly the estimation of the coefficients of substitution for the individual trip categories, based on the estimates of the 1991 study of Arthur D. Little, and, therefore, on the French study of 1980 (Economic Research Centre 1983: 36/37; see previous discussion of 1991 study). On the other hand, the greatest value of the study, whose forecasts seem to be overly optimistic for the telecommunications side, is that it caused the airline industry to turn more attention to this issue. Arthur D. Little received a considerable response by the aviation industry and might continue research in this area, probably involving a more empirical methodology.

Study by Arvai (1994); Table 4.2.2.2-3

Another study that focuses on telecommunications-air travel interactions has been recently conducted by The Arvai Group. Also this approach suffers from the weakness that only the substitutionary effect on travel is addressed. As in the Arthur D. Little study, it is assumed that no substantial growth in business and, therefore, travel needs will result from new telecommunications technologies. Instead, productivity gains will promote streamlining and rationalization of workforces. Even if an individual would experience a stimulation of travel, this effect is washed out by more global organizational trends. However, with respect to the discussion in section 4.1.2, the concentration on a mere trade-off relation and the neglecting of all other more complex interactions between telecommunications and travel can be seen as a significant deficiency of this approach.

This study is actually not completed yet and is intended to be continued on an expanded empirical basis with a more global orientation, involving around 1,000 corporations instead of the 75 U.S. companies that the current assessments are based upon.

Projections of an overall substitution of business air travel in 2010 by 19% (low substitution scenario) to 29% (high and expected substitution scenario), respectively, are based on statistical analyses of historical market data of the telecommunications and air travel industry, future growth projections for the teleconferencing market, and particularly on a survey of user experience, observations, preferences, and evaluations. These data have not been accessible due to

proprietary reasons. The two scenarios analyzed assume different levels of market penetration of videoconferencing as function of the digital network infrastructure development.

Objectives	<ul style="list-style-type: none"> ➤ Assessment of telecommunications impact on air travel; concentration on substitution and on questions how much, when, and for what functions this substitution will be evident. ➤ Multi-client study with focus on U.S. market; continuing study with expansion of survey sample size (up to 1,000 companies instead of currently 75) and toward more world-wide examinations.
Approach	<ul style="list-style-type: none"> ➤ Survey among 75 companies with domestic and international business relationships; not all of them are videoconferencing users; primarily executives. ➤ Projections for substitution impact are based on statistical data of market penetration of telecommunications technology, forecasts of future teleconferencing market development, and on survey data regarding user experience, observations, acceptance, preferences, and future plans; judgmental interpretation of these data in order to estimate substitution coefficients. ➤ Distinguishing of two scenarios: "low" and "high/most probable"; assuming different levels and speeds of market penetration, primarily with respect to digital network development; assumption of fully developed infrastructure by 2010.
Results	<ul style="list-style-type: none"> ➤ Stimulation effect marginal; productivity and efficiency gains from videoconferencing for individuals, inducing new travel opportunities, are washed out through streamlining of workforce being enabled by increase of productivity due to enhanced teleconferencing applications. ➤ Emergence of technological change brings desktop video and other interactive multi-media tools, which revolutionize the way businesses are conducted; more face-to-face interactions will be involved in future business communications, but with reduced travel; however, impacts on travel are varying and depending on industry, company and business characteristics, and geographical factors. ➤ Projections for substitution of business trips: 2000: 5% (low) - 13% (high); 2005: 11%-19%; 2010: 19%-29%; percentages on basis of projected baseline growth scenario; monetary quantification of this impact in terms of dropping demand for new aircraft of manufacturers: around \$100 billion.
Judgment	<ul style="list-style-type: none"> ➤ Focus on substitution; argumentation against stimulation effect not convincing and neglecting the highly complex interaction potential between modern telecommunications and travel. ➤ Validity of substitution estimates questionable; historical data and projections for teleconferencing market do not provide information about real adoption patterns of technology and are, therefore, a weak basis for estimates of telecommunications/travel interactions; linkage between survey data and qualitative evaluations of substitution potential not possible to analyze (proprietary data). ➤ Overall, substitution estimates seem to significantly overstate real impact.

More face-to-face communications would be involved in future business communications. However, contrary to the theory supported by Mokhtarian (1988; 1990) and some others, this is not expected to lead to more travel but to a travel reduction in absolute terms. The study also suggests that the impact on travel will be rather different depending on industry, business and organizational structure of company, and geographical aspects.

Due to the lack of access to survey data and the derivations of projections, it is not possible to fully assess the soundness of this study. However, according to Ernest S. Arvai (interview with author), president of The Arvai Group, there is a good amount of intuitive judgment included in the interpretation of historical trends, market projections, and user evaluations and experiences. However, it is still questionable as to what extent statistical relationships of telecommunications and travel can provide any evidence for conclusions supporting competitive, substitutionary interactions between both modes (see section 4.1.1).

According to Salomon and Schofer (1988: 226), assumptions about similarities between past and future technology impact patterns are both risky and dependent on weakly supported judgment. Furthermore, with respect to the use of market statistics in this approach, it should be considered that penetration defines only the availability of a technology and does not give information what usage patterns actually occur and whether this usage affects transportation.

Study by Apogee Research (1994); Table 4.2.2.2-4

Finally, the study of Apogee Research, which has been conducted in commission of the FAA, should be discussed. The work addresses as key objectives the changes in the nature of air travel demand, especially in the business area, and the factors underlying these changes with particular interest on videoconferencing and other advanced telecommunications. Furthermore, a quantification of the substitution potential is applied. Although stimulation is not quantified -- due to general problems regarding its measurement (see section 4.1.2.2), its consideration in the interpretation and application of substitute estimates is addressed.

The statistical analysis performed by Apogee is based on 15 years of historical data and comprises various econometric models for forecasting future demand developments for U.S. air travel, disaggregated by pleasure and business purposes. This econometric approach and its results have been discussed specifically in section 2.5.2.

Objectives	<ul style="list-style-type: none"> ➤ Analysis of changes in the nature of business air travel demand (statistical understanding and predictability); examinations of changes being underway, such as videoconferencing and other advanced telecommunications, which could continue to influence the level and type of air passenger demand. ➤ Quantification of impact of telecommunications on air travel demand.
Approach	<ul style="list-style-type: none"> ➤ Disaggregated statistical analysis of historical trends in business and leisure air travel demand (prime data sources: ATA, FAA, IATA, and Shifflet and Associates; see sections 2.1.2, 2.3.1, 2.3.2, and 2.4.2). ➤ Development of econometric models for forecasting future demand for business and pleasure travel (see section 2.5.2). ➤ Qualitative evaluation of benefits, barriers and impacts on air travel demand of emerging telecommunications technologies; analysis of potential usages to meet business needs → estimates of substitution potential for specific business travel purposes expecting full substitution capability by 2005 ("low" and "high" scenario; based on categorization of Shifflet, see section 2.1.2); application of estimates to percentage breakdown of business travel (Shifflet data, see section 2.1.2) in order to determine net impact.
Results	<ul style="list-style-type: none"> ➤ Notable change in the nature of business demand; increased price sensitivity and search for alternative modes to fulfill business needs → videoconferencing. ➤ Substitution effect more measurable and quantifiable than stimulation of business travel by modern telecommunications; therefore, stimulation not included in impact quantification, although it may be assumed that gains in productivity and efficiency associated with videoconferencing might offset some (if not all) of direct demand loss due to replacement of personal face-to-face communications for certain business purposes by videoconferencing. ➤ Videoconferencing is most adequately suited to meet specific group travel needs and particularly travel for job interviews; net future substitution of U.S. business air travel due to telecommunications: 1.7% (low) - 10.8% (high), representing 1% - 4% of total U.S. air travel.
Judgment	<ul style="list-style-type: none"> ➤ Interesting econometric modeling of business and pleasure travel demand; however, lack of data (ATA surveys) these analyses are based on has to be considered (see discussion in section 2.5.2); furthermore, problem with projection of future demand based on historical statistics if nature of demand has changed; adjustment to changed price sensitivity of business demand difficult. ➤ Quantification of substitution potential is lacking empirical support; highly speculative; however, although not quantified, recognition of complementary relationship of telecommunications and travel and its need to be considered in interpretation of substitution quantifications. ➤ Lacking application of substitution estimates to baseline demand projections; neglecting growth of substitution as function of time and its increasing impact on projected annual growth rates of business demand (baseline scenario); instead, application of substitution estimates to projected U.S. business air travel share in 2005 (!?).

The impact of telecommunications on business air travel is qualitatively discussed with respect to different emerging technologies and their potential uses. Also, the quantification of the substitution potential for individual business purposes -- according to classification of Shifflet and Associates (see section 2.1.2) -- is done on a highly subjective and speculative basis, which lacks empirical support. Videoconferencing is seen as being most adequate suited to meet specific group meeting needs. In the transient travel area, job interviews are assessed to be most sensitive to substitution by videoconferencing.

The highly subjective substitution coefficients are put in relationship to the percentage shares of each trip purpose of total U.S. air travel demand taken from Shifflet and Associates. The final projections for the substitution potential of U.S. business air travel expected to be reached by 2005 range from 1.7% ("low" scenario) to 10.8% ("high" scenario).

Finally these estimates are applied to the baseline projection of business travel in 2005 derived from the econometric modeling. However, by applying substitution estimates to projected demand data at one point of time, as done in the Apogee study, it is not considered that the effect of telecommunications will continuously underlie business travel growth in the future and that annual travel replacement rates may increase throughout the period till 2005.

Therefore, applying substitution coefficients to projected demand in 2005 overstates the impact since the full substitution potential is not expected to be reached before this time and lower annual replacement rates will be effective in the prior years. Substitution estimates have to be applied to annual growth rates of business travel.

Although the statistical approach and the econometric modeling also contain weaknesses (see section 2.5.2), they are probably the most valuable contributions of this study to the literature analyzing business air travel trends, characteristics and sensitivities to enhanced telecommunications.

4.2.2.3 Overall Assessment of Studies

The discussion of several research studies in the field of telecommunications versus business travel shows that significant deficiencies are apparent, particularly with respect to empirical research and evidence to support any substitution or stimulation theories.

Although the qualitative and theoretical studies (section 4.2.2.1) are evenly divided in papers addressing substitution, and those supporting complementary interactions between both modes, the studies that specifically address the relationship of teleconferencing and business air travel, and quantify the impact on air travel demand (section 4.2.2.2) mostly neglect stimulation and other long-term, more indirect interactions. The specific problems associated with the measurement and quantification of stimulation may be significant reasons for this. As consequence, the studies appear to overstate the substitution impact.

In addition, the quantifications of potential travel substitution are not sufficiently supported by empirical evidence and are in many cases almost entirely based on speculative evaluations. If empirical data are provided -- e.g., experiences and observations of users, they are often based on small sample sizes and a limited context. In many cases, empirical data of substitution are project-based or site-based. Travel reduction might be measurable in such cases. However, more global impacts of enhanced teleconferencing media on corporate business and organizational structures in a long-term perspective are widely neglected.

In several cases, quantifications for substitution rates are based on trends in travel budgets and travel frequency. It is questionable to what extent the contribution of modern telecommunications to such trends can be filtered out from all the other factors internal and external to a company that underlie travel budget and frequency developments. Nevertheless, even if quantifications of potential substitution of up to 29% in the most recent studies (in average between 10% and 20%, in some earlier studies even higher) are overstating the real impact, the projections made in these studies have generated a notable echo in the airline industry and made it more conscious of this issue. This may provide an incentive to initiate more substantial research in the area of telecommunications versus air travel, undoubtedly necessary if future air transportation planning is to have a sound footing.

With respect to most studies discussed in section 4.2.2.1, the time of their execution has to be seen as a significant limitation for their integration into today's discussion of this issue. Arguments and theories provided in some of these studies are in need for a new validation and empirical support. Videoconferencing has been a very quickly developing technology throughout the last few years. Even in only three to five years, significant changes have occurred in the technology itself, as

well as in the cost differential relative to travel and with respect to market acceptance, penetration and adoption patterns.

Videoconferencing has developed from a tactical tool to become a strategic business tool and is associated with much more far-reaching objectives, although in times of searching for productivity gains and ways of streamlining workforces, travel costs remain under pressure.

Nevertheless, the studies contain some interesting and valuable analytical approaches -- e.g., statistical and econometrical approach in Apogee study (1994), or mathematical modeling of price-income sensitivity in Schuler (2/1992), as well as essential theoretical and qualitative discussions of preferences, drivers, characteristics, dependencies, and sensitivities underlying the interactions of telecommunications and business travel.

Several studies, particularly Bennison (4/1988), Mokhtarian (4/1988; 3/1990), Salomon and Schofer (3/1988), address the complex interrelationships between telecommunications and transportation and go in their analysis beyond the mere substitution trade-off. Reasonable argumentation for the existence of a complementary relationship is given. However, the empirical support for these hypotheses is lacking.

In the present state of research, it seems to be almost impossible to claim scientifically that modern telecommunication technologies are, or will be, a substitute for business air travel, or to claim the opposite. Much empirical work is necessary in the future, considering all potential impacts, not only the substitution effect on various forms of in-person face-to-face meetings.

Telecommunications experts appear often to be more optimistic on the subject of travel substitution while transportation specialists are more skeptical. And, even if both agree on the desirability of substitution of certain types of travel, they undoubtedly assess the scope very differently (Economic Research Centre 1983: 78). Studies by experts of the telecommunications side often stress cost and time savings and see empirical evidence for communication and business effectiveness of modern teleconferencing applications, particularly videoconferencing, compared with natural face-to-face meetings. Transportation experts, on the other hand, generally also recognize the technological and economic feasibility of travel substitution, but stress psychological, cultural, social, and organizational obstacles

and see specific individual preferences for travel -- secondary incentives -- even though meetings might be substitutable through videoconferencing.

4.3 Cost-Benefit Analysis

This section focuses on the simple cost trade-off between videoconferencing and travel and discusses parameters being considered in a financial investment analysis. Qualitative trades between both modes are examined in exemplary case studies by using a software tool called "VC/COST" designed for the purpose of such a financial analysis by KJH Communications, Atlanta, Georgia. This software has been furnished on a complimentary basis to assist this thesis.

4.3.1 Justification of Videoconferencing Investment Through Replacement of Business Travel

Although travel savings by far are not the only benefit reported by companies using videoconferencing already for several years -- and in many cases, they are also not the primary and most evident ones --, the fact that these savings seem to be much easier quantifiable than other benefits (such as increases in employee productivity and efficiency, improvement of teamwork among geographically dispersed sites, advancement of competitiveness, or overall gains in effectiveness of communication processes) cause most financial analyses justifying an investment in videoconferencing to be based on travel cost and time replacements. Such approaches neglect several aspects discussed earlier in the thesis and assume a cause-effect relationship between travel cost reduction and videoconferencing.

With the cost of videoconferencing equipment and services declining rapidly and with the cost of travel holding steady or even increasing, it is relatively simple to accomplish a positive financial analysis to support the purchase of videoconferencing based solely on travel avoidance (KJH Communications 1994: 4-8). However, the subsequent case studies show that there are also certain trades making traveling more favorable for specific occasions and meeting forms -- even when based on cost alone.

Costs of air travel have dramatically declined over time, largely due to improvement of aircraft technology. Nevertheless, only incremental improvements rather than further breakthroughs in the price performance of air travel are expected for the future. Air travel costs have more or less matured. The opposite is true for

the telecommunication industry, particularly for its most quickly growing segment, videoconferencing (Arvai 1994: 6/7). The development of the costs of videoconferencing equipment and services has been discussed in more detail in section 3.4.

Figure 4.3.1-1 illustrates the different situation of videoconferencing and travel costs and emphasizes the continuous improvement of the cost performance of videoconferencing relative to business air travel, making the latter one progressively less capable to compete in terms of price. Today, most financial analyses for videoconferencing are able to predict payback periods of under two years -- based solely on travel savings (KJH Communications 1994: 7-34).

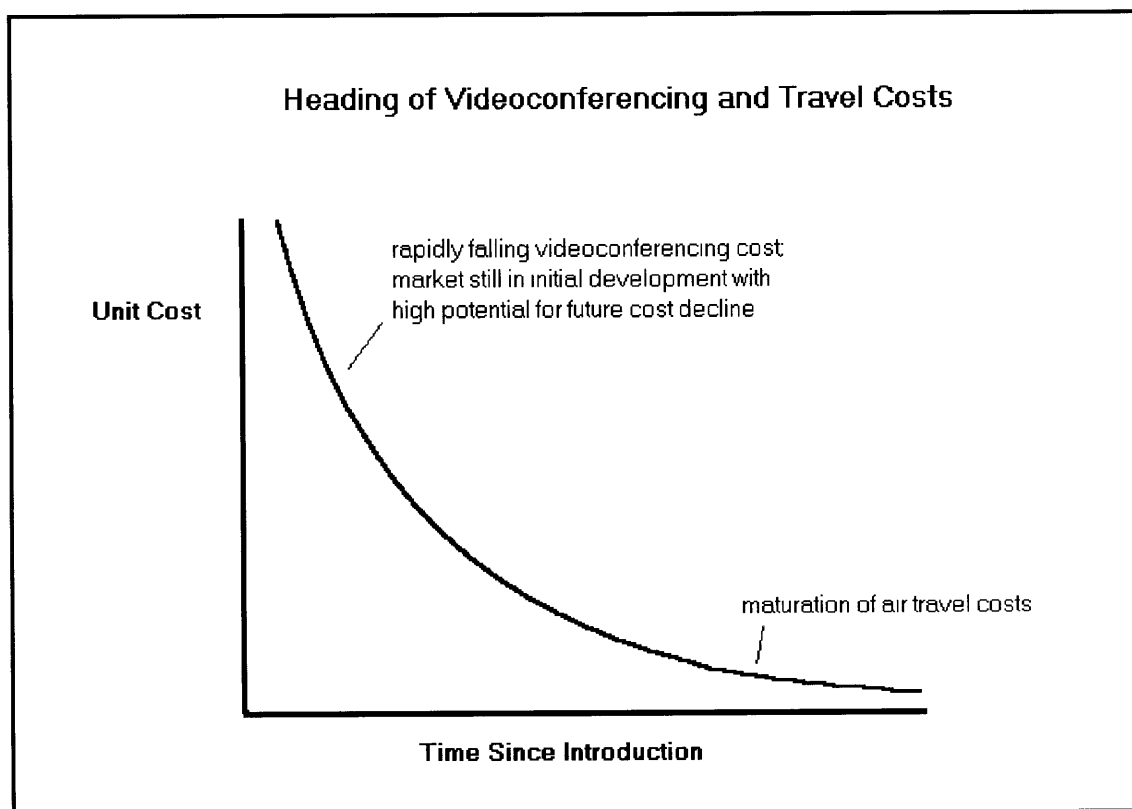


Figure 4.3.1-1: Heading of Videoconferencing and Travel Costs

The software tool applied to the exemplary case studies being discussed in section 4.3.3 basically contains a financial comparison of the two scenarios of doing business without videoconferencing, and of doing business with videoconferencing. It compares videoconferencing capital and operating costs to travel expenses including the cost of unproductive time associated with each business trip.

However, "VC/COST" offers the integration of additional costs of traveling or benefits of videoconferencing in form of revenue improvement from increased productivity and competitiveness -- if the company feels able to provide reasonable estimates (KJH Communications 1994: 4-4 - 4-7).

On the other hand, it must not be neglected that travel is associated with additional benefits deriving from the in-person experience, larger interaction capability and employee motivation, or satisfaction through social, cultural and recreational aspects involved in certain business trips, particularly in the international area. If they can be estimated, "VC/COST" offers the quantification of these benefits as additional cost of doing business with videoconferencing.

In the subsequent case analyses, neither additional benefits or costs of business travel, nor those of videoconferencing are included since any quantification would rely on a highly speculative basis. Only capital and operating costs of videoconferencing, and the expenses of travel and unproductive time are considered.

Quantifiable Costs of Business Travel:

The expenses of business air travel that can be avoided by the use of videoconferencing are air fares, cost of hotels, meals and ground transportation, and miscellaneous costs associated with certain trips, e.g., entertainment. These costs can be determined or at least approximated through surveys or travel statistics.

Another cost incurred when doing business air travel is the cost of unproductive time. This cost is in most cases almost as great as -- or even greater than -- the out-of-pocket expenses listed above. Unproductive time during travel usually comprises time spent commuting to and from airports on originating and destination legs of a trip, time spent at airports waiting for flights or ground transportation, time spent commuting to and from meeting locations, and, of course, time spent on-board of an aircraft that cannot be used for work activities (KJH Communications 1994: 6-15). For these times, estimates have to be determined by the analyst.

The overall unproductive time is then multiplied by the traveler's hourly salary equivalent and a percentage that represents the company's payroll costs for Social Security, Medicare, retirement, and other employer contributions. The software allows the inclusion of these quantifications, depending on interpretation, as costs avoided through videoconferencing or as revenue improvement through increased

employee productivity when doing business with videoconferencing (KJH Communications 1994: 4-6).

While most ground time involved in travel is unproductive, it is possible to argue about the quantification of unproductive air time. To what extent this time can be used by individual business travelers varies. However, it should be considered that the integration of modern telecommunications, such as phone, fax, laptops, or even videoconferencing (Business & Commercial Aviation January 1994: 33-34), into on-board facilities contributes to higher productivity and feasibility of business air travel. In the subsequent case analyses, 50% of the air time are assumed to be unproductive. This is only an assumption since a generalization is not possible.

In the case of doing business with videoconferencing, no unproductive time is considered because the use of in-house systems is quickly accessible for the participants and associated with marginal unproductive access and egress times.

4.3.2 Elements of the Financial Analysis

The categories considered in the cost-benefit analysis are the following:

- Videoconferencing capital equipment costs
- Videoconferencing operating expenses
- Meeting characteristics
- Business travel expenses
- Unproductive travel time
- General financial parameters

The elements included in each of the categories listed above are described in Table 4.3.2-1. The quantifications applied to the case studies are discussed in section 4.3.3.

The software "VC/COST" conducts a financial analysis taking into consideration present and future values of funds, depreciation, and the effects of inflation, tax, and employee benefits. The output of the analysis comprises a 5-year financial scenario for both cases -- videoconferencing versus business travel -- that are finally compared by looking at discounted net gain or loss (cumulative discounted net cash flow total = difference of cumulative discounted net cash flows of both scenarios) from the installation of a videoconferencing system, and the payback period (simple and discounted) associated with a positive financial case for videoconferencing.

Table 4.3.2-1: Elements of the Financial Analysis	
<i>Category</i>	<i>Elements</i>
Videoconferencing capital equipment costs	<ul style="list-style-type: none"> ↳ Total of capital equipment costs for each videoconferencing location, including costs of system, codecs, installation, network access equipment, inverse multiplexer, room modification, furnishings, building wiring, and various optional equipment.
Videoconferencing operating expenses	<ul style="list-style-type: none"> ↳ Telecommunication costs for each location and meeting type: <ul style="list-style-type: none"> ▪ Monthly access charges. ▪ Hourly transmission costs. ↳ Annual maintenance costs for all sites -- as percentage of capital costs. ↳ Administrative salary expenses for each site (site coordinator and other management personnel). ↳ Other annual expenses, e.g., promotion, training, certain carrier services.
Meeting characteristics	<ul style="list-style-type: none"> ↳ Monthly meeting frequency. ↳ Average number of participants per site that would have traveled without videoconferencing. ↳ Average duration of meeting.
Business travel expenses	<ul style="list-style-type: none"> ↳ Average travel costs: <ul style="list-style-type: none"> ▪ Air fares. ▪ Number of overnight stays. ▪ Daily costs for lodging, meals, rental car, parking, personal auto (as number of local miles between home/office and airport), and other ground transportation.
Unproductive travel time	<ul style="list-style-type: none"> ↳ Annual salary level of meeting participants. ↳ Average amount of unproductive time (air and ground).
General financial parameters	<ul style="list-style-type: none"> ▪ Inflation rate ▪ Tax rate ▪ Discount rate ▪ Employee benefits cost (as percentage of salary) ▪ Effective work hours per year per employee

Source: KJH Communications, 1994.

4.3.3 Case Studies

In the following, a cost-benefit analysis comparing business travel and videoconferencing is performed for different domestic and international point-to-point and multipoint meetings. The choice of specific case studies instead of a more general and analytical approach derives from the fact that the costs of telecommunications

and travel vary with contexts and circumstances. Particularly the variability of business travel costs makes a more generalized, non-site-specific study infeasible. Air fares usually -- especially in deregulated environments -- do not show a functional relationship to distance, as they are based on demand and competition, and, consequently, rates are market specific. There is no sensible average air fare for a certain length of haul in the U.S. after deregulation. Therefore, the analysis of air travel costs compared to the cost of videoconferencing is more appropriate and effective in a specific case study rather than in a general approach (Salomon et al. 18/1991: 295).

Also, telecommunication costs are not directly distance dependent. Factors as infrastructure, bandwidths, transmission medium, and demand primarily determine these costs. Furthermore, carriers apply different charging schemes ranging from mileage-based approaches to sector-based rates. And, especially in the international area large variations are apparent, which cannot be generalized.

However, though the results of this cost-benefit analysis are based on specific locations and meeting types, the findings, especially qualitative trends and sensitivities of the results, have a general applicability. The objective of the analysis is not to examine a specific investment scenario of a company evaluating videoconferencing installations at certain sites. Short and long haul domestic and international meetings involving point-to-point and multipoint conferences are assessed and compared with respect to sensitivity to parameters as number of participants, duration of meeting, frequency of monthly conferences, and value of time (salary level) of conferencees.

4.3.3.1 Assumptions and Input Data

Basic Assumptions:

Doing a financial analysis for the investment in videoconferencing as applied in this section basically assumes that cost alone affects the choice between both alternative modes enabling face-to-face interaction and ignores other benefits associated with using an advanced communication tool as videoconferencing, but also advantages associated with in-person meetings involving travel.

In the cases being analyzed, it is assumed that the investment is made for specific routine intra-company meetings among geographically dispersed sites. This assumption reflects the results determined in several surveys and studies -- also in

the survey for the purpose of this thesis (see 4.5) -- that today about 90% of all videoconferences are intra-company.

The intra-company case implies that all costs, fixed and variable, are incurred by the same company. A videoconferencing system is assessed only for a particular point-to-point or multipoint application. It is ignored that a system can also be used for different internal and external applications. However, this assumption is reasonable since, as stated before, no net cash flows and payback periods for a certain company-wide investment should be addressed, but rather qualitative trades and sensitivities with respect to participation size, meeting length and frequency, salary level, and domestic and international meetings. The recognition of these qualitative behaviors is only possible when analyzing specific applications in an isolated form.

It is assumed that the sample company has its headquarters in Boston and that in-person meetings normally take place there, implying that participants in the non-videoconferencing scenario have to travel from their locations to Boston. The following eight meeting scenarios are assessed subsequently:

- ☒ Point-to-Point: Boston - New York
- ☒ Point-to-Point: Boston - San Francisco
- ☒ Point-to-Point: Boston - Berlin
- ☒ 3-Point: Boston - Chicago - New York
- ☒ 3-Point: Boston - Chicago - San Francisco
- ☒ 3-Point: Boston - Chicago - Berlin
- ☒ 4-Point: Boston - Chicago - New York - San Francisco
- ☒ 4-Point: Boston - Chicago - New York - Berlin

Meetings involving San Francisco and Berlin at the same time are not considered since the 9-hour time difference between both cities allows no overlapping of usual working hours, which is a general problem for international videoconferencing applications.

It is presumed that meetings using videoconferencing are as effective as in a real in-person atmosphere. Although studies have shown that in videoconferences, participation is often higher and duration shorter compared with corresponding physical face-to-face meetings (see section 3.7 and 3.8), no differences are assumed in this analysis. On the other hand, since only travel costs are dependent on the number of participants, the parameter "participants per site" can be

interpreted as the number of employees per site normally having to travel to the meeting in Boston. Additional participants in a videoconference would not influence this kind of analysis.

Also, the monthly meeting frequency is set equal for both scenarios, although users claim that videoconferencing would allow the so-called impossible meeting, a gathering that would not have occurred before videoconferencing was available.

Input Data:

The elements being included in the cost-benefit analysis are addressed in section 4.3.2. Table 4.3.3.1-1 provides an overview of the input data for the scenarios being assessed for the purpose of this study. As said before, all capital and operating costs have to be considered since intra-company meetings are assumed as applications.

The capital costs are based on the assumption that a slightly larger system is used in the Boston videoconferencing room since it will likely contain larger groups, and might be more frequently used. The cost data derive from average system and component prices and cost ranges provided in the user's guide to "VC/COST". For Boston, the capital costs of \$115,000 contain a basic conference system including codec and installation of about \$60,000. This represents a typical price for a more sophisticated roll-about system. The additional costs contain network access equipment, inverse multiplexer, various optional equipment, such as graphics workstation and facsimile machine, room modification, and furnishings. In case of multipoint meetings, the cost of a multipoint control unit (MCU; ~\$85,000) are included, representing a cost-efficient decision for companies in need for regular conferences involving multiple locations and implying independence of bridging services of the exchange carriers.

The systems in the other sites are smaller. Typical roll-about systems of basic costs of about \$40,000 to \$45,000 are assumed. No MCU is needed at these locations and also costs for room modification and furnishings are presumed to be lower than in Boston.

For video transmission, 112 kbps are chosen (domestic and international). 112/128 kbps are the most widely applied transmission speeds in the U.S., accounting for about 55% of the group videoconferencing marketplace (Halhed, Scott September 1993: 28). This transmission bandwidth is assumed to be based

on the combination of two switched 56 kbps lines (2×56 kbps). For the network access, T-1 lines are chosen allowing the flexible combination of 56/64 kbps increments on a call-by-call basis. As stated in section 3.3.1, this form is most popular among users of public switched digital services. An inverse multiplexer needed for the dial-up of separate lines is considered in the capital costs for each video location.

Access charges (city-center locations) and undiscounted, basic transmission costs for June 1994 are provided by AT&T Global Business Video Services. The data for Berlin are estimates. Access charges are usually slightly higher in Germany while the half-circuit charge of Deutsche Telecom is estimated to be around the level of that of AT&T.

The expenses for equipment maintenance and administrative salary are oriented on typical ranges provided in KJH Communications' user's guide (1994: 6-8 - 6-11, 7-6/7). In addition, \$10,000 per year are presumed as start-up expenses for promoting videoconferencing in the firm and training of users.

The meeting characteristics -- monthly frequency, number of conference participants, and duration of meeting -- are variable in the analysis.

Air fares are average full coach class fares (unrestricted; June 1994) for roundtrips between the different sites and Boston. It is assumed that participants at an in-person meeting in Boston traveling from Berlin stay two nights independently of the meeting length and those from San Francisco one night for conferences up to 8 hours. For a 16-hour meeting, a two-night stay is assumed for business travelers from San Francisco and one overnight stay for those coming from New York and Chicago. In case of shorter meetings, no overnight stay is applied to both latter conference scenarios.

Expenses for meals, lodging, rental car, parking, and personal car are estimated on basis of Runzheimer's survey data (1992) and figures provided in the user's guide of KJH Communications (1994) and in Salomon (18/1991). A subjective adjustment for the price levels in Boston generally being above nationwide averages has been applied.

For the analysis, two different values of time are compared. The salary level for middle management is based on estimates of an average value by the Bureau of Labor Statistics (Salomon et al. 18/1991: 316). The annual salary for executives/senior management is subjectively assumed. As said earlier, 50% of the

air time are presumed to be unproductive. This assumption is applied to the average scheduled flight times (roundtrip) for the corresponding city-pairs. Unproductive ground time is set to three hours per meeting and participant traveling.

The financial parameters are based on estimates and typical values provided in the user's guide of "VC/COST" (KJH Communications 1994: 6-8/9, 7-8) and in the FAA's U.S. economic outlook (FAA 1994: II-5).

<i>Category</i>	<i>Elements</i>
Videoconferencing capital equipment costs	<ul style="list-style-type: none"> ↳ <u>Boston</u>: \$115,000 for point-to-point cases, including basic system and codec costs of about \$60,000; \$200,000 for multipoint meetings, including additional Multipoint Control Unit (MCU). ↳ <u>Other Sites</u>: \$80,000 per site for all meeting forms, including basic system and components of around \$45,000.
Videoconferencing operating expenses	<ul style="list-style-type: none"> ↳ Telecommunication costs for each location and meeting type: <ul style="list-style-type: none"> ▪ Monthly access charges (T-1 line; according to AT&T, June 1994): <ul style="list-style-type: none"> ➢ Boston: \$836 per month. ➢ Chicago: \$837 per month. ➢ New York: \$947 per month. ➢ San Francisco: \$589 per month. ➢ Berlin: ~\$1,000 per month (estimate). ▪ Hourly transmission costs (112 kbps; basic, non-discounted charges; according to AT&T Global Business Video Services, June 1994): <ul style="list-style-type: none"> ➢ Boston - New York: \$20 per hour. ➢ Boston - Chicago: \$24 per hour. ➢ Boston - San Francisco: \$28 per hour. ➢ Boston - Berlin: ~\$550 per hour (based on AT&T half-circuit charge of \$290; Deutsche Telecom's half-circuit rate estimated). ↳ Annual maintenance costs for all sites: 10% of equipment costs. ↳ Administrative salary expenses for each site (site coordinator and other management personnel): <ul style="list-style-type: none"> ➢ Boston: \$30,000 per year. ➢ Other sites: \$5,000 per year. ↳ Other annual expenses (cumulative for all sites): \$10,000 as start-up costs for promoting videoconferencing in company and training users.
Meeting characteristics	<p>Variables in case studies:</p> <ul style="list-style-type: none"> ↳ Monthly meeting frequency. ↳ Average number of participants per site that would have traveled without videoconferencing: 1, 2, 4, 6. ↳ Average duration of meeting: 0.5 hr, 1 hr, 2 hrs, 4 hrs, 8 hrs, 16 hrs.

Table 4.3.3.1-1 (Cont'd): Input Data for Case Analyses	
Category	Elements
Business travel expenses	<ul style="list-style-type: none"> ↳ Average travel costs: <ul style="list-style-type: none"> ▪ Air fares (average full coach class fares for roundtrip, June 1994): <ul style="list-style-type: none"> ➢ New York - Boston: \$300 ➢ Chicago - Boston: \$891 ➢ San Francisco - Boston: \$1,424 ➢ Berlin - Boston: \$1,268 ▪ Number of overnight stays: <ul style="list-style-type: none"> ➢ New York - Boston: no overnight, only in case of 16-hour meeting one overnight stay. ➢ Chicago - Boston: same applies as above. ➢ San Francisco - Boston: one overnight, only in case of 16-hour meeting two overnights. ➢ Berlin - Boston: two overnight stays in all cases. ▪ Other average daily travel expenses base on data from Runzheimer (1992) and other sources having inquired about those (adjusted for usually higher price levels in Boston, meeting location for in-person conferences in all cases): <ul style="list-style-type: none"> ➢ Lodging: \$100 per night. ➢ Meals: \$40 per day. ➢ Car rental: \$40 per day. ➢ Parking: \$15 per day. ➢ Personal car (roundtrip mileage for office/home - airport): 50 mi
Unproductive travel time	<ul style="list-style-type: none"> ↳ Annual salary level of meeting participants: <ul style="list-style-type: none"> ➢ Executives/Senior Management: \$100,000 (assumption). ➢ Middle Management: \$47,000 (based on estimate of Bureau of Labor Statistics from 1991, adjusted for inflation). ↳ Average amount of unproductive air time; assumption: 50% of total roundtrip air time: <ul style="list-style-type: none"> ➢ New York - Boston: 1 hour. ➢ Chicago - Boston: 2½ hours. ➢ San Francisco - Boston: 7 hours. ➢ Berlin - Boston: 10 hours. ↳ Average amount of unproductive ground time (equal for all meetings): <ul style="list-style-type: none"> ➢ <u>3 hours per meeting</u>, comprising 1 hour for commuting to/from airport, 1 hour waiting for flights, taxis, and rental cars, and 1 hour for commuting to/from meeting locations.
General financial parameters	<ul style="list-style-type: none"> ▪ Inflation rate: 3% per year. ▪ Tax rate: 40%. ▪ Discount rate: 10%. ▪ Employee benefits cost (as percentage of salary): 45%. ▪ Effective work hours per year per employee: 1,800 hours.

4.3.3.2 Results and Interpretation

For all meeting scenarios, two different analyses are performed. In the first, the monthly meeting frequency necessary to payback the videoconferencing investment in the 5-year period considered in the software tool is determined as function of the number of participants, meeting duration, and salary level.

The second analysis assumes a weekly meeting frequency. For all scenarios, the meeting form preferable with respect to cumulative discounted net cash flow is determined. In cases of a positive financial analysis for videoconferencing, the payback period in months is provided in addition.

The objective of this analysis is the recognition of qualitative trends, dependencies, and sensitivities in the trade-off relationship between travel and videoconferencing with respect to variations of different meeting characteristics and salary levels. However, a more extensive analysis could also examine sensitivities and relative trades with respect to variations in videoconferencing equipment used, transmission bandwidths chosen, or service and fare classes preferred on the flights.

Basic Trends:

Analyzing the results illustrated in the Tables 4.3.3.2-1 to 4.3.3.2-9, several basic trends can be recognized.

With increasing meeting length, travel becomes an increasingly preferable alternative since travel costs are insensitive to the duration of a conference -- considered as productive time -- and the portion of unproductive time of total travel time involved in the meeting declines. Costs of videoconferencing, on the other hand, do show a direct sensitivity to the length of a meeting due to transmission rates charged on an hourly basis. However, this basic trend is not apparent in all scenarios to the same extent. Furthermore, it has to be considered that an additional overnight stay associated with a 16-hour meeting impacts this basic relationship in favor of videoconferencing.

As opposed to this relationship, travel costs are highly sensitive to the number of participants having to travel. While with increasing size of conference participation, out-of-pocket expenses for air travel, hotels, meals, etc., and the cost of unproductive time grow proportionally, videoconferencing costs are insensitive to

this parameter. Nearly all results show the dramatically improving cost performance of videoconferencing relative to travel with an increasing number of participants.

With a growing number of monthly meetings, travel costs usually grow more quickly than videoconferencing expenses due to the larger marginal cost of traveling. Therefore, videoconferencing becomes an increasingly favorable alternative with rising meeting frequency.

The improvement of the relative cost-benefit performance of videoconferencing with increasing value of time (salary level) is obvious. However, the significance of this impact varies among the analyzed scenarios.

The problem of a generalization of sensitivities to travel distance has been addressed earlier. Nevertheless, the comparison of domestic short-distance and long-distance meetings shows that travel is favorable for most of the short-haul applications (Boston-New York), but the price performance significantly deteriorates relative to videoconferencing for coast-to-coast applications (Boston-San Francisco). While air fares and particularly unproductive time clearly increase in the latter case, domestic transmission costs are relatively insensitive to distance. However, the hypothesis that videoconferencing becomes more favorable with increasing distance has to be limited to the domestic market. On the international basis, high hourly transmission charges cause a deterioration of the cost performance of videoconferencing, especially for small participation. This negative effect is compensated in case of an increasing number of conferencees by the even higher sensitivity of travel costs to the number of people traveling.

Point-to-Point Scenarios:

The lower sensitivity of transmission costs to distance is apparent when comparing the point-to-point cases Boston-New York (Table 4.3.3.2-1) and Boston-San Francisco (4.3.3.2-2). In the latter case, ticket costs and unproductive time per business traveler increase significantly, inducing a much lower number of monthly meetings necessary for payback of a videoconferencing investment. Using videoconferencing (in case of four monthly meetings) is preferable for all meeting types involving more than one participant per site in the San Francisco scenario.

The insensitivity of travel to the length of the meeting is apparent in the New York case for small meeting participation. In the coast-to-coast applications, this advantage of traveling is outweighed by the high air fares and the high relative

portion of unproductive travel time, even for longer meeting lengths. Almost no sensitivity to duration is evident for Boston-San Francisco.

The high sensitivity of travel expenses to the number of participants is apparent in both scenarios. Even, in the Boston-New York scenario, it weighs more than the underlying insensitivity of travel to meeting duration. In a drastic form, this relationship is evident in the San Francisco example when involving six participants per site. Payback periods decline to as low as one month.

Table 4.3.3.2-1: Cost Analysis for Point-to-Point Case: Boston-New York													
Middle Management							Executives/Senior Management						
Monthly Meeting Frequency Necessary for Payback of Videoconferencing Investment													
<i>Particip. p. Site</i>	<i>Duration of Meeting (Hours)</i>						<i>Particip. p. Site</i>	<i>Duration of Meeting (Hours)</i>					
	0.5	1	2	4	8	16		0.5	1	2	4	8	16
1	20	20	21	22	26	24	1	15	15	16	17	19	17
2	10	10	10	11	11	9	2	8	8	8	8	9	7
4	5	5	5	5	6	5	4	4	4	5	5	5	4
6	4	4	4	4	4	3	6	4	4	4	4	4	3
Preferable Meeting Form (4 Monthly Meetings)*													
<i>Particip. p. Site</i>	<i>Duration of Meeting (Hours)</i>						<i>Particip. p. Site</i>	<i>Duration of Meeting (Hours)</i>					
	0.5	1	2	4	8	16		0.5	1	2	4	8	16
1	T	T	T	T	T	T	1	T	T	T	T	T	T
2	T	T	T	T	T	T	2	T	T	T	T	T	T
4	T	T	T	T	T	T	4	V59	V60	T	T	T	V48
6	V50	V50	V51	V52	V55	V32	6	V30	V30	V31	V31	V32	V23

*: V: Videoconferencing preferable (number behind "V" indicates payback period in months); T: Travel preferable.

The impact of higher values of time is more apparent for smaller meeting participation, especially in the New York case. For an increasing number of conferencees, the differences in the payback meeting frequency diminish and the effect of higher salary levels is only observable in shorter payback periods.

In the Boston-New York scenario with the assumption of four monthly meetings, travel would be preferable for the majority of meeting types. Only for some 4-hour meetings (executives/senior management) and all 6-hour meetings, would videoconferencing be the more cost-efficient alternative.

The point-to-point Boston-Berlin case shows a dramatic sensitivity to the duration of the meeting, derived from the high transmission rates charged for such

international conferences and the insensitivity of travel cost to meeting duration at the same time. For certain meeting lengths and participation, no payback is possible at all since the marginal costs of videoconferencing for these types of meetings are always higher than those of traveling. On the other hand, high air fares, the necessity of two overnight stays, and the high unproductive time induce a high sensitivity of the trade-off relation to the number of participants. Also, the impact of an increased value of time is apparent for small participation.

Middle Management							Executives/Senior Management						
Monthly Meeting Frequency Necessary for Payback of Videoconferencing Investment													
<i>Particip. p. Site</i>	<i>Duration of Meeting (Hours)</i>						<i>Particip. p. Site</i>	<i>Duration of Meeting (Hours)</i>					
	0.5	1	2	4	8	16		0.5	1	2	4	8	16
1	6	6	6	6	6	6	1	5	5	5	5	5	5
2	4	4	4	4	4	4	2	3	3	3	3	3	3
4	2	2	2	2	2	2	4	2	2	2	2	2	2
6	1	1	1	1	1	1	6	1	1	1	1	1	1
Preferable Meeting Form (4 Monthly Meetings)*													
<i>Particip. p. Site</i>	<i>Duration of Meeting (Hours)</i>						<i>Particip. p. Site</i>	<i>Duration of Meeting (Hours)</i>					
	0.5	1	2	4	8	16		0.5	1	2	4	8	16
1	T	T	T	T	T	T	1	T	T	T	T	T	T
2	V48	V48	V49	V50	V53	V48	2	V35	V35	V35	V36	V37	V35
4	V18	V18	V18	V18	V18	V17	4	V14	V15	V15	V15	V15	V14
6	V1	V1	V1	V1	V1	V1	6	V1	V1	V1	V1	V1	V1

*: V: Videoconferencing preferable (number behind "V" indicates payback period in months); T: Travel preferable.

Overall, for most of these international meetings, videoconferencing represents the favorable alternative. And, in spite of significantly higher transmission charges, payback meeting frequencies and periods are in most cases clearly lower than in the Boston-New York scenario, and are comparable to those in the Boston-San Francisco scenario for participation of four and more people per site.

Table 4.3.3.2-4 shows the financial analysis for all previous point-to-point cases combined, meaning that an investment for all these point-to-point applications is considered at the same time. The impact of the significant sensitivity to meeting length in the New York and Berlin cases is apparent for small participation. Also

here, the high international transmission charges do not allow a payback for one-to-one meetings over 16 hours.

Table 4.3.3.2-3: Cost Analysis for Point-to-Point Case: Boston-Berlin													
Middle Management							Executives/Senior Management						
Monthly Meeting Frequency Necessary for Payback of Videoconferencing Investment													
<i>Particip. p. Site</i>	<i>Duration of Meeting (Hours)</i>						<i>Particip. p. Site</i>	<i>Duration of Meeting (Hours)</i>					
	0.5	1	2	4	8	16		0.5	1	2	4	8	16
1	6	7	9	57	-	-	1	5	5	7	15	-	-
2	4	4	5	7	30	-	2	3	3	3	5	8	-
4	2	2	2	2	3	15	4	1	2	2	2	2	6
6	1	1	1	1	2	3	6	1	1	1	1	1	2
Preferable Meeting Form (4 Monthly Meetings)*													
<i>Particip. p. Site</i>	<i>Duration of Meeting (Hours)</i>						<i>Particip. p. Site</i>	<i>Duration of Meeting (Hours)</i>					
	0.5	1	2	4	8	16		0.5	1	2	4	8	16
1	T	T	T	T	T	T	1	T	T	T	T	T	T
2	V49	V55	T	T	T	T	2	V33	V35	V43	T	T	T
4	V17	V18	V19	V23	V39	T	4	V13	V14	V15	V17	V23	T
6	V1	V1	V1	V13	V16	V36	6	V1	V1	V1	V1	V1	V19

*: V: Videoconferencing preferable (number behind "V" indicates payback period in months); T: Travel preferable.

However, payback meeting frequencies and periods for gatherings with two or more participants per site are even lower than in the most favorable point-to-point case for videoconferencing, Boston-San Francisco. This emphasizes that the consideration of a multiple installation of systems in different sites of a company and, therefore, the usage of facilities for different applications -- in this case, of the Boston system for three different point-to-point meetings -- significantly improves the price performance of videoconferencing relative to travel.

Table 4.3.3.2-4: Cost Analysis for All Previous Point-to-Point Cases Combined													
Middle Management							Executives/Senior Management						
Monthly Meeting Frequency Necessary for Payback of Videoconferencing Investment													
<i>Particip. p. Site</i>	<i>Duration of Meeting (Hours)</i>						<i>Particip. p. Site</i>	<i>Duration of Meeting (Hours)</i>					
	0.5	1	2	4	8	16		0.5	1	2	4	8	16
1	5	5	5	8	45	-	1	4	4	5	5	13	-
2	2	3	3	3	4	12	2	2	2	2	2	3	5
4	1	1	2	2	2	2	4	1	1	1	1	1	2
6	1	1	1	1	1	1	6	1	1	1	1	1	1
Preferable Meeting Form (4 Monthly Meetings)*													
<i>Particip. p. Site</i>	<i>Duration of Meeting (Hours)</i>						<i>Particip. p. Site</i>	<i>Duration of Meeting (Hours)</i>					
	0.5	1	2	4	8	16		0.5	1	2	4	8	16
1	T	T	T	T	T	T	1	V56	V60	T	T	T	T
2	V25	V26	V27	V35	V60	T	2	V20	V20	V22	V25	V35	T
4	V1	V1	V1	V13	V15	V20	4	V1	V1	V1	V1	V1	V14
6	V1	V1	V1	V1	V1	V1	6	V1	V1	V1	V1	V1	V1

*: V: Videoconferencing preferable (number behind "V" indicates payback period in months); T: Travel preferable.

3-Point Scenarios:

Comparing the three 3-Point meeting scenarios (Table 4.3.3.2-5 to Table 4.3.3.2-7) confirms the basic trends recognized in the point-to-point cases. Sensitivity to meeting duration is again apparent for small participation in the short-distance domestic meeting Boston-Chicago-New York and particularly in the international case involving Berlin. On the contrary, almost no time sensitivity is existent in the 3-point meeting involving San Francisco. The effect of air fares and unproductive time increasing drastically in this case and of the marginal sensitivity of transmission charges to meeting length underlie this observation.

The results are susceptible to the value of time primarily in the international scenario and for small participation in the short-distance domestic case.

Overall, the Boston-Chicago-New York scenario is most favorable for travel, especially for small participation, while the cases involving San Francisco and Berlin are favorable for videoconferencing in most of the analysis. In the latter two cases, the high sensitivity of travel costs to the number of participants having to travel

without videoconferencing implies extremely small payback meeting frequencies and short payback periods.

4-Point Scenarios:

The 4-point scenarios (Table 4.3.3.2-8 and Table 4.3.3.2-9) only differ from each other notably in terms of sensitivity to meeting length and, to a lesser extent, with respect to the value of time. Both sensitivities are apparent in the international case for small participation. Otherwise, wide similarities in the results of both scenarios are recognizable. In addition, the Boston-Chicago-New York-San Francisco case provides almost identical results to the 3-point scenario Boston-Chicago-San Francisco, whereas the payback frequencies and periods in the international 4-point scenarios are for most cases very similar to those in the international counterpart of the 3-point analyses. This shows that the favorable trades for traveling recognized in the 2-point meetings Boston-New York have almost no impact on the results of the 4-point meetings when New York is integrated into the cases Boston-Chicago-San Francisco and Boston-Chicago-Berlin, respectively. Disadvantageous trades for travel in the domestic long-haul applications and in international meetings with increasing number of conferencees outweigh these favorable trades in the New York application.

Overall, the above results show that no single threshold exists where one medium is preferable to the other. Costs are dependent on various factors comprising location, number of participants, length of meeting, monthly meeting frequency, salary levels, and different factors kept constant in the previous analyses, such as type of technology and transmission form used, or air fares chosen.

A company has to look at its own specific circumstances and needs for making a decision which mode is preferable -- even when the decision is based solely on the simple cost trade-off. Of course, as said in earlier sections of the thesis, several other factors have to be considered additionally and weighted between videoconferencing and business travel. What types of meeting are usually held between the sites under consideration for a videoconferencing investment? What messages are to be conveyed? And, what is the value of an in-person atmosphere with respect to the meeting outcome? All these questions have to recognize that despite continuously improving technology and increasing acceptance by users (see section 3.7), the interaction potential in a videoconferencing may not be sufficient with respect to the capability actually needed for particular meeting purposes.

Table 4.3.3.2-5: Cost Analysis for 3-Point Case: Boston-Chicago-New York													
Middle Management							Executives/Senior Management						
Monthly Meeting Frequency Necessary for Payback of Videoconferencing Investment													
Particip. p. Site	Duration of Meeting (Hours)						Particip. p. Site	Duration of Meeting (Hours)					
	0.5	1	2	4	8	16		0.5	1	2	4	8	16
1	9	9	10	10	11	11	1	8	8	8	8	9	9
2	6	6	6	6	7	6	2	5	5	5	5	5	5
4	3	3	3	3	3	2	4	2	2	2	2	2	2
6	2	2	2	2	2	2	6	2	2	2	2	2	2
Preferable Meeting Form (4 Monthly Meetings)*													
Particip. p. Site	Duration of Meeting (Hours)						Particip. p. Site	Duration of Meeting (Hours)					
	0.5	1	2	4	8	16		0.5	1	2	4	8	16
1	T	T	T	T	T	T	1	T	T	T	T	T	T
2	T	T	T	T	T	T	2	T	T	T	T	T	T
4	V31	V31	V31	V32	V33	V26	4	V23	V23	V24	V24	V24	V21
6	V18	V18	V18	V18	V19	V15	6	V14	V14	V15	V15	V15	V13

*: V: Videoconferencing preferable (number behind "V" indicates payback period in months); T: Travel preferable.

Table 4.3.3.2-6: Cost Analysis for 3-Point Case: Boston-Chicago-San Francisco													
Middle Management							Executives/Senior Management						
Monthly Meeting Frequency Necessary for Payback of Videoconferencing Investment													
Particip. p. Site	Duration of Meeting (Hours)						Particip. p. Site	Duration of Meeting (Hours)					
	0.5	1	2	4	8	16		0.5	1	2	4	8	16
1	5	5	5	5	6	6	1	5	5	5	5	5	5
2	3	3	3	3	3	3	2	2	2	2	3	3	2
4	2	2	2	2	2	2	4	1	1	1	1	2	1
6	1	1	1	1	1	1	6	1	1	1	1	1	1
Preferable Meeting Form (4 Monthly Meetings)*													
Particip. p. Site	Duration of Meeting (Hours)						Particip. p. Site	Duration of Meeting (Hours)					
	0.5	1	2	4	8	16		0.5	1	2	4	8	16
1	T	T	T	T	T	T	1	T	T	T	T	T	T
2	V33	V34	V34	V34	V36	V33	2	V25	V26	V26	V26	V27	V26
4	V14	V14	V14	V14	V15	V13	4	V1	V1	V1	V1	V1	V1
6	V1	V1	V1	V1	V1	V1	6	V1	V1	V1	V1	V1	V1

*: V: Videoconferencing preferable (number behind "V" indicates payback period in months); T: Travel preferable.

Table 4.3.3.2-7: Cost Analysis for 3-Point Case: Boston-Chicago-Berlin													
Middle Management							Executives/Senior Management						
Monthly Meeting Frequency Necessary for Payback of Videoconferencing Investment													
Particip. p. Site	Duration of Meeting (Hours)						Particip. p. Site	Duration of Meeting (Hours)					
	0.5	1	2	4	8	16		0.5	1	2	4	8	16
1	5	6	7	13	-	-	1	4	5	6	8	-	-
2	3	3	3	5	7	-	2	2	2	3	3	5	63
4	2	2	2	2	2	3	4	1	1	1	2	2	2
6	1	1	1	1	1	2	6	1	1	1	1	1	1
Preferable Meeting Form (4 Monthly Meetings)*													
Particip. p. Site	Duration of Meeting (Hours)						Particip. p. Site	Duration of Meeting (Hours)					
	0.5	1	2	4	8	16		0.5	1	2	4	8	16
1	T	T	T	T	T	T	1	V59	T	T	T	T	T
2	V33	V36	V41	T	T	T	2	V25	V26	V29	V36	T	T
4	V13	V14	V15	V17	V21	V42	4	V1	V1	V1	V13	V15	V23
6	V1	V1	V1	V1	V1	V15	6	V1	V1	V1	V1	V1	V1

*: V: Videoconferencing preferable (number behind "V" indicates payback period in months); T: Travel preferable.

Table 4.3.3.2-8: Cost Analysis for 4-Point Case: Boston-Chicago-New York-San Francisco													
Middle Management							Executives/Senior Management						
Monthly Meeting Frequency Necessary for Payback of Videoconferencing Investment													
Particip. p. Site	Duration of Meeting (Hours)						Particip. p. Site	Duration of Meeting (Hours)					
	0.5	1	2	4	8	16		0.5	1	2	4	8	16
1	5	5	5	6	6	6	1	5	5	5	5	5	5
2	3	3	3	3	3	3	2	2	2	2	3	3	2
4	2	2	2	2	2	2	4	1	1	1	1	2	1
6	1	1	1	1	1	1	6	1	1	1	1	1	1
Preferable Meeting Form (4 Monthly Meetings)*													
Particip. p. Site	Duration of Meeting (Hours)						Particip. p. Site	Duration of Meeting (Hours)					
	0.5	1	2	4	8	16		0.5	1	2	4	8	16
1	T	T	T	T	T	T	1	T	T	T	T	T	T
2	V35	V35	V36	V37	V39	V34	2	V26	V27	V27	V27	V29	V26
4	V15	V15	V15	V15	V15	V14	4	V1	V1	V1	V1	V1	V1
6	V1	V1	V1	V1	V1	V1	6	V1	V1	V1	V1	V1	V1

*: V: Videoconferencing preferable (number behind "V" indicates payback period in months); T: Travel preferable.

Table 4.3.3.2-9: Cost Analysis for 4-Point Case: Boston-Chicago-New York-Berlin													
Middle Management							Executives/Senior Management						
Monthly Meeting Frequency Necessary for Payback of Videoconferencing Investment													
<i>Particip. p. Site</i>	<i>Duration of Meeting (Hours)</i>						<i>Particip. p. Site</i>	<i>Duration of Meeting (Hours)</i>					
	0.5	1	2	4	8	16		0.5	1	2	4	8	16
1	6	6	7	11	-	-	1	5	5	5	7	38	-
2	3	3	3	4	6	-	2	2	3	3	3	4	11
4	2	2	2	2	2	3	4	1	1	2	2	2	2
6	1	1	1	1	1	2	6	1	1	1	1	1	1
Preferable Meeting Form (4 Monthly Meetings)*													
<i>Particip. p. Site</i>	<i>Duration of Meeting (Hours)</i>						<i>Particip. p. Site</i>	<i>Duration of Meeting (Hours)</i>					
	0.5	1	2	4	8	16		0.5	1	2	4	8	16
1	T	T	T	T	T	T	1	T	T	T	T	T	T
2	V33	V35	V40	V57	T	T	2	V25	V25	V29	V34	V60	T
4	V15	V16	V18	V20	V22	V31	4	V1	V1	V1	V13	V15	V19
6	V1	V1	V1	V1	V1	V13	6	V1	V1	V1	V1	V1	V1

*: V: Videoconferencing preferable (number behind "V" indicates payback period in months); T: Travel preferable.

4.4 Evaluations of Industry Participants and Analysts

This section gives an overview of current evaluations of the issue videoconferencing versus business travel by vendors of videoconferencing equipment, telecommunications exchange carriers, analysts of the videoconferencing market, airframe makers, and international airlines. It shows the existence of a variety of opinions and arguments.

One might assume that subjectivity of participants or analysts would cause evaluations more favorable for their own industry. However, though this aspect may underlie individual opinions, the overall assessment profile within each industry group is heterogeneous, and even within the same company divergent evaluations are evident. Although these opinions are related to specific companies or organizations, it has to be considered that they are based on a personal, subjective point of view.

4.4.1 Point of View of the Telecommunications Side

Most assessments by representatives of the telecommunications and videoconferencing industry found in the literature and certain publications, or received in

interviews with the author of this study confirm discussions in earlier sections of the thesis.

The majority of experts agree that due to the need to justify a videoconferencing investment in monetary terms and the fact that savings in travel caused by the use of videoconferencing are the benefits that are easiest quantifiable, travel replacement is still a prime factor in investment analyses. On the other hand, there is also a wide agreement that travel substitution as a more tactical gain is certainly not the most significant benefit experienced by users of videoconferencing yet.

Nevertheless, while strategic benefits are increasingly evident and also superior to benefits from travel replacement, the assessment of the actual impact on business travel in a company having adopted to videoconferencing is divergent (see Table 4.4.1-1).

Strategic Significance of Videoconferencing:

According to John Ruchinskas, consultant of the Telecommunications Research Group in Culver City, California (Wakin March/April 1994: 30; conversation with author), savings in travel cost and time are in most cases only the first reasons companies turn to video. Businesses soon explore additional gains, such as faster decision-making, more timely actions, new opportunities for serving customers, winning new clients, and improved cooperation internal and external to company.

Kathleen J. Hansell (KJH Communications 1994: 4-2; conversation with author), president of KJH Communications, sets forth that almost all users and technology experts agree that the real benefits of videoconferencing are far beyond simple travel savings.

Effects of videoconferencing depend on several company specific factors, according to Daniel C. Hunt, AT&T manager for Accumaster Videoconferencing Management Services (interview with author). However, there is still a lack in knowledge about the real values of videoconferencing -- particularly in monetary terms, which, undoubtedly, are more in the strategic area rather than in form of mere travel substitution. More efficient tracking schemes have to be developed in companies using videoconferencing in order to quantify these benefits.

And finally, also Chuck Horn, manager of marketing for Sprint Video Group (Feldman 9/1993: 46), confirms that companies use travel savings as fallback to justify capital investment in videoconferencing. However, it is now observed that

this happens less and less, and that the customers are increasingly interested in whether videoconferencing is going to help them compete and increase productivity, rather than to save travel costs.

A summary of the above evaluations and some additional opinions are given in Table 4.4.1-1.

Neutral or Positive Impact of Videoconferencing on Business Travel:

The hypothesis of modification of travel patterns and even stimulation of overall business travel in a company as consequence of an investment in videoconferencing is shared by several representatives of vendors and exchange carriers, as well as by consultants and industry analysts. Some exemplary assessments are provided here.

According to Paul Saffo (Autumn 1993: 112-119), researcher and consultant at the Institute for the Future, Menlo Park, California, instead of pursuing travel substitution, users of modern teleconferencing systems, such as videoconferencing, have become a group of "travel shifters". The teleconferencing technology allows them to move the inevitable business trip around on the calendar to suit personal and group convenience. Thus, travel shifting implies a means of short-term substitution but also increased travel on a long-term perspective. By making travel more manageable through using sophisticated communication tools as videoconferencing, business people are traveling more than ever.

Kathleen J. Hansell (KJH Communications 1994: 4-1/2; conversation with author) confirms that only a few companies mandate reductions in overall travel budgets as a direct result of videoconferencing. However, decreases in travel between certain sites where videoconferencing systems are installed are observable, primarily where the destinations are not particularly appealing or where competition and project completion pressures are significant. Nevertheless, while travel may decline on such routes, it might in fact grow for other business purposes benefiting from the increased efficiency and productivity in doing certain activities with videoconferencing.

Table 4.4.1-1: Evaluations by Representatives of the Telecommunications Side

Strategic Significance of Videoconferencing
<p>⊗ Savings in travel costs and time are only initial reasons for the adoption to videoconferencing; businesses of all sizes soon recognize other benefits, such as acceleration of decision-making, more timely actions, new opportunities to serve customers, winning new clients, and improved cooperation internal and external to company (John Ruchinkas, consultant of the Telecommunications Research Group (TRG), Culver City, California).</p> <p>⊗ Real benefits of videoconferencing are far beyond mere travel savings (Kathleen J. Hansell, president of KJH Communications, Atlanta, Georgia).</p> <p>⊗ Issues of videoconferencing installation become those of increased productivity and efficiency, improved management communications, and enhanced business opportunities (Ann Earon, president of Telemanagement Resources International (TRI), Lake Wylie, South Carolina).</p> <p>⊗ Effects of videoconferencing on company's communications and businesses are rather complex and certainly not limited to simple travel savings (Ivonne Brown, manager in marketing, PictureTel, Peabody, Massachusetts).</p> <p>⊗ Impacts of videoconferencing depend on several company specific factors; however, there is a lack in knowledge about the real values which, undoubtedly, are in the strategic area (Daniel C. Hunt, AT&T manager for Accumaster Videoconferencing Management Services).</p> <p>⊗ Significance of travel savings in investment justification is declining; videoconferencing is more and more seen as a competitive and productivity tool (Chuck Horn, manager for marketing for Sprint Video Group).</p>
Neutral or Positive Impact on Business Travel
<p>⊗ Videoconferencing users become a group of "travel shifters"; enhanced telecommunications allow to shift the inevitable business trip to suit personal and group convenience; travel shifting implies a measure of short-term substitution but long-term stimulation of travel; by making business travel more manageable, business people are traveling more than ever (Paul Saffo, research fellow at the Institute for the Future, Menlo Park, California).</p> <p>⊗ Only a small number of companies have observed a decrease in their annual travel expenses as a result of videoconferencing; travel between certain sites where video systems have been installed might decline, but is highly probable to increase for other business purposes benefiting from the efficiency and productivity gain through the usage of videoconferencing for certain business activities (Kathleen J. Hansell, president of KJH Communications, Atlanta, Georgia).</p> <p>⊗ Most users soon recognize that videoconferencing has nothing to do with travel savings; in several instances, travel increases rather than decreases as result of videoconferencing (Ann Earon, president of Telemanagement Resources International (TRI), Lake Wylie, South Carolina).</p>

Table 4.4.1-1 (Cont'd): Evaluations by Representatives of the Telecommunications Side

Neutral or Positive Impact on Business Travel (Cont'd)
<p>⊗ Travel savings are certainly not a main driver for an investment in videoconferencing; overall, a re-allocation of travel dollars within the company occurs; the dynamics and patterns of business travel change; new business opportunities are provided, generating new needs to travel as a result of videoconferencing (John Champa, manager of telecommunications at Unisys).</p> <p>⊗ Videoconferencing reduces travel to some locations -- particularly internal to the company -- but allows for increased travel to customers and other externals (Taya Harmon, marketing director for visual solutions business at AT&T Global Business Communications Systems).</p> <p>⊗ Substitution of travel might occur in certain cases but overall it is only marginal; if substitution occurs, it is mostly a replacement of audioconferencing and, therefore, an upgrading of less interactive communication tools (Daniel C. Hunt, AT&T manager for Accumaster Videoconferencing Management Services).</p> <p>⊗ The payback of videoconferencing is not in displacement of travel, but in time-to-market (Glenn Riggin, general manager of AT&T Global Business Video Services).</p> <p>⊗ Videoconferencing does not eliminate the need for in-person meetings; it does allow to meet "face-to-face" when time is limited or travel impractical (AT&T Global Business Services, promotional brochure <i>Making More Time For Business</i>).</p> <p>⊗ Although many customers initially buy videoconferencing to save on air travel, the latter one soon grows back to its former level after the system is fully adopted (PictureTel).</p>
Videoconferencing as Substitute for Travel
<p>⊗ There is a high substitution potential of videoconferencing for business travel; only for room-to-room applications (no desktop video) substitution potential of 10% to 15% expected -- although it is hardly likely to be reached in the near future; even in recent past and today, substitutionary effect has been underlying business travel development (Jeff Charles, industry analyst at the Institute for the Future, Menlo Park, California).</p> <p>⊗ About two thirds of respondents to survey among companies of "Fortune 1000" industry group reported more or less replacement of travel by videoconferencing (Yankee Group, Boston consultant).</p> <p>⊗ Implementing videoconferencing, on average, cuts corporate travel costs by 18% (Telemanagement Resources International (TRI), Lake Wylie, South Carolina).</p> <p>⊗ Although substitution, stimulation, and modification of travel occur simultaneously, a net reduction of physical "face-to-face" meetings is apparent; the extent varies from company to company and depends on promotion of videoconferencing within the firm, videoconferencing and travel policies, experience, and organizational and business structure (Ivonne Brown, manager in marketing, PictureTel, Peabody, Massachusetts).</p>

About 70% of the customers of Telemanagement Resources International (TRI), according to Ann Earon (Feldman 9/93: 46), need to cut travel expenses and initially assess travel substitution as the prime benefit of installing video-

conferencing. Nevertheless, most of them -- within six months of adopting the technology -- recognize that videoconferencing has little to do with travel substitution. In some instances, clients actually find that travel increases rather than decreases as a result of videoconferencing.

The previous evaluations and observations are supported by John Champa (interview with author), videoconferencing manager at Unisys, a company with a long-term experience in multimedia and videoconferencing technology. He stated that savings in travel expenses are certainly not the main drivers for using videoconferencing in his company. Some short-term substitution might occur, but in the longer term, a re-allocation of dollars spent on travel is observable within the company. The dynamics and patterns of traveling change; new business opportunities are provided, generating new needs to travel. Instead of a weekly one-day business trip to another site of the company in the U.S., an additional monthly trip -- due to time constraints not possible before -- to a supplier in East Asia can be done, for example.

Several providers of videoconferencing equipment and services do not see videoconferencing significantly replacing the demand for air travel. According to PictureTel (Hughes November 29, 1993: 40), although many customers initially buy videoconferencing to save on travel expenses, business travel at a company soon grows to its former level after the system is fully adopted.

Also other evaluations see videoconferencing more as a complement to travel, generating its own demand. An overview of the assessments discussed above and of additional points of views supporting them is given in Table 4.4.1-1.

Videoconferencing as Substitute for Travel:

As opposed to the assessments discussed previously, also the theory of significant travel substitution by videoconferencing is shared by telecommunications industry analysts and representatives of vendors and exchange carriers.

Jeff Charles (conversation with author), analyst and consultant at the Institute for the Future, sees a high potential for substitution of business travel by enhanced telecommunications. This effect would have been underlying business travel developments in the recent few years, but no tracking schemes have existed to support this theory. On a room-to-room system basis (not including desktop video applications), the total substitution potential is estimated by Charles to be between

10% and 15%. The emerging desktop video systems would further contribute to this travel replacement potential. However, it will take time to reach this total substitution capability -- about 10 to 15 years. On the other hand, Charles also sees a chance for the travel industry to react. It must be creative and try to take advantage of the telecommunications technology.

According to the Yankee Group (Feldman 9/1993: 45), a Boston consultant, about two thirds of respondents to a survey -- conducted among a group of "Fortune 1000" companies' telecommunications and information systems professionals about the use of videoconferencing to replace travel -- reported a high (16% of respondents) or low and moderate, respectively, (51%) replacement of travel through videoconferencing in their companies. However, this survey was conducted during the Gulf crisis in 1991 and, therefore, under rather different circumstances -- also with respect to the level of videoconferencing technology development and costs.

Telemanagement Resources International (TRI; Finn, Galanin October 11, 1993: 41), suggests that implementing videoconferencing, on average, cuts corporate travel costs by 18%. This number is based on a survey of users. However, it is in contrast to the statement of TRI's president, Ann Earon, quoted above with respect to the neutral and positive impact on business travel.

Although the effects of videoconferencing on businesses of a company are very complex, and substitution, modification, and stimulation of travel can occur simultaneously, a net reduction of natural face-to-face meetings is apparent, according to Ivonne Brown, manager of marketing for PictureTel. The extent varies from company to company and depends on promotion of videoconferencing within the firm, videoconferencing and travel policies, experience, and organizational and business structure.

Overall, the previous discussion has shown how heterogeneous existing opinions as regards the relationship between videoconferencing and business air travel are. However, the most widely shared opinion appears to be that travel savings are no longer the main driver of an investment in videoconferencing systems although they are still widely used for short-term justification of the investment. Furthermore, many experts agree that a modification of travel patterns without a net elimination of air travel is most probable to occur as consequence of an adoption of video-

conferencing. A short-term substitution of certain business trips is often associated with a long-term generation of new business travel needs.

4.4.2 Assessment by the Aviation Industry

The following discussion bases on the responses received from the survey of airframe manufacturers and international airlines in Europe, North America, and East Asia conducted for the purpose of this study (see Appendix 3 and 4). As stated earlier, the degree of response to the questionnaires has been less than expected.

Several airlines and McDonnell Douglas did not feel able to give evaluations regarding the aspects enclosed in the questionnaires due to a lack of own research in this area. Their current efforts to deal with the issue of telecommunications versus business air travel is often limited to monitoring of general literature and publicly accessible study results -- the most important of them have been discussed in section 4.2. Nevertheless, several airlines, although not feeling able to give quantified estimates, have generally responded to this study by stating that they believe business travel will be impacted by enhanced telecommunications as videoconferencing in form of substitution. However, the question for most of these airlines is to what extent and in which business areas this substitution effect is and/or will be evident.

Interesting is also that McDonnell Douglas, although not having conducted a detailed study of the relationship of modern teleconferencing technologies and air travel, named trends in the telecommunications area as reasons for the downward correction of its most recent traffic projections (see section 2.5.1; Dornheim March 14, 1994: 72).

Only a few airlines are undertaking or planning to undertake more serious research in this area. However, extensive short-term problems most air carriers are currently faced with in their operations seem to have prevented airlines from paying more attention to the emerging telecommunications technologies and their potential impacts on business air travel. The aviation industry has certainly not sufficiently dealt with this issue so far and does not seem to be prepared to effectively response to this potential substitute product (see discussion of substitutes in section 2.2).

Response to Survey:

Airlines having answered the questionnaire designed for this thesis and whose responses are integrated into the subsequent discussion are American Airlines, Japan Airlines, KLM, Olympic Airways, Swissair, and USAir. On the manufacturers' side, sufficient response has been received from Airbus Industrie, Deutsche Aerospace Airbus, and Boeing.

These airlines and manufacturers based their evaluations primarily on qualitative judgment. Studies seem to be under way at Boeing and Airbus and also at a few airlines, but reliable results do not appear to exist yet. Regarding the approach to this issue, three main research areas are named: (1) the identification of business purposes for which videoconferencing is primarily used (target groups), (2) an estimation of the substitutability for business travel in each of these categories identified, and (3) a more detailed knowledge of the composition of business air travel by trip motivation. Airlines and manufacturers admit that a lack in knowledge of the split among types of business travel is apparent and no significant research has been done in this field.

Airlines and manufacturers that have started more serious research in the field of telecommunications versus air travel are primarily concentrating on field trials and surveys among business travelers and corporations having installed multimedia and videoconferencing systems. Furthermore, several consulting companies -- some of them have already been conducted studies in this field (see section 4.2) -- may expand past studies or conduct new research in commission of major airlines. However, approaches similar to those stated above are widely applied.

The extent to which airlines and manufacturers are seriously considering the issue of videoconferencing versus business air travel (question 4 in both questionnaires; see Appendix 3 & 4) was evenly assessed as "a little" and "increasingly", whereas the majority of respondents admitted to integrate this aspect into corporate, long-term planning only to "a little" extent (question 5 in both questionnaires). However, the manufacturers agreed about its increasing importance with respect to future aircraft developments, such as the Ultra High Capacity Aircraft (UHCA), and primarily the High Speed Civil Aircraft (HSCA), whose focus group are undoubtedly business travelers (question 7 manufacturers' survey).

Quantified Evaluations:

According to more than half of the respondents, a slight substitution impact has already been underlying business travel growth in the recent several years and today (question 3 in both questionnaires; Appendix 3 & 4). The evaluations range from (-0.5) to (-1.5) on a non-dimensional scale from (-3) -- high substitution -- to (+3) -- high stimulation, which was used in the M.I.T. survey. The overall average of the given assessments -- equally weighed -- is (-0.4).

For the evaluations of the future potential impact of videoconferencing and enhanced telecommunications on the demand for air travel (see questions 1 and 8 in manufacturers' questionnaire and questions 1 and 7 in airlines' questionnaire), the same rating scale from (-3) to (+3) has been chosen. A graphical summary of the responses received is provided in Figure 4.4.2-1.

On a global basis, it is expected that the impact of videoconferencing on air travel demand will be in form of a slight substitution. Half of the respondents rated it with (-0.5). The average value of all responses is (-0.69).

From the markets considered in the survey -- basically, the major world air travel markets, the U.S. domestic market is evaluated to have the highest substitution potential (average of (-1.12)). 50% of respondents rated it with (-1.5) or (-2.0). Also, the North Atlantic business travel market is seen as being highly sensitive to the emergence of sophisticated videoconferencing systems (average of (-1.07)). The majority of ratings are at a level of (-1.0) or (-1.5). Both markets clearly received the highest ratings with respect to the substitution potential by videoconferencing.

The potential of travel substitution in the Pacific (average: (-0.7)) and Intra-Asian (average: (-0.5)) markets is assessed higher than that of the Intra-European (Common European) market. While the majority rated the Pacific market as (-1.0), the assessment with respect to the Intra-Asian market is rather heterogeneous. However, in the latter case, a tendency toward slight substitution can be determined. The substitution potential for European business air travel is seen at a level of 0 to (-0.5).

Business travel between Europe and Asia is expected to be even less affected by enhanced telecommunications (average: (-0.37)). However, also here, an incoherent assessment profile is apparent, ranging from a rather high substitution of (-1.5) to a slight stimulation of (+0.5).

The only market expected to benefit from enhanced telecommunications is -- not surprisingly -- the Eastern European air travel market (domestic and international) with an average rating of (+0.58). The clear majority of respondents assessed the stimulation potential between (+0.5) and (+1.5). With the poor telecommunications and transportation infrastructure in most parts of Eastern Europe, especially in the former U.S.S.R., modern telecommunications, such as videoconferencing, are evaluated as an important contributor to the development of business relationships among the Eastern European countries and between those and the western world and, therefore, also to the growth of business air travel in these markets.

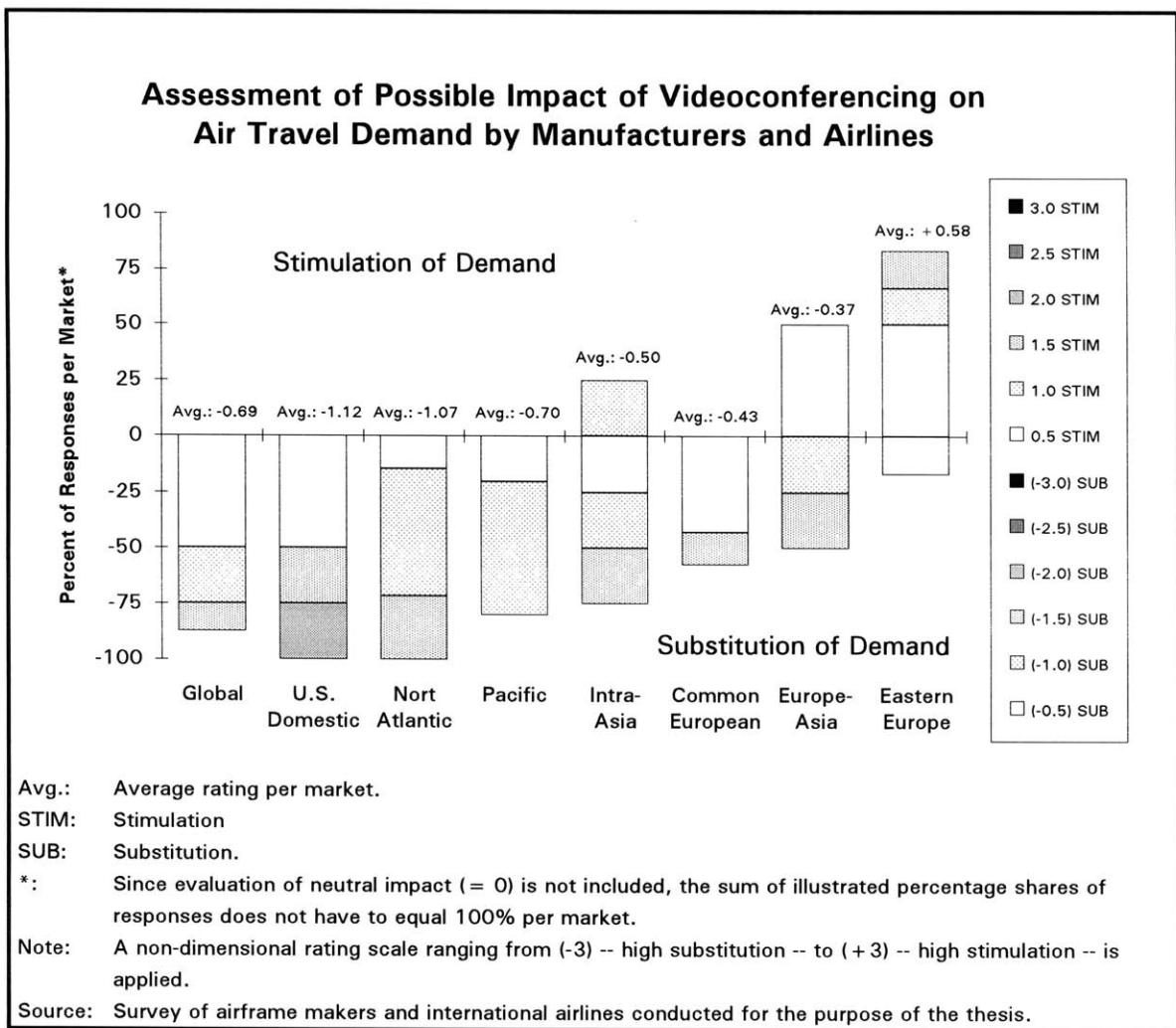


Figure 4.4.2-1: Assessment of Possible Impact of Videoconferencing on Air Travel Demand by Manufacturers and Airlines

Regarding the length of haul (question 9 in manufacturers' survey and question 8 in airlines' survey), the long-haul markets around the globe are seen by the majority of respondents (two thirds) as showing the most notable impact of videoconferencing in the future.

Subsequently, some suggestions received with respect to the possible response of the airline industry to the "threat" of telecommunications (question 10 in manufacturers' survey and question 9 in airlines' survey) are listed. They range from the recognition that trying to head off telecommunications in terms of price would not work, and passive response in form of downsizing of capacity and future growth strategies, to offensive response suggestions in terms of taking advantage of videoconferencing and integrating it in the airlines' product profile. However, the following statements also prove that convincing ideas are widely lacking and a lot of questions are open:

- ↳ "We have to think over our offer."
- ↳ "Ask the airlines." -- a response of one of the manufacturers;
- ↳ "Replacement of lost business travelers through stimulation of pleasure travel demand -- however, it is questionable whether this would be a good trade."
- ↳ "Concentration on pleasure market."
- ↳ "Price cuts do not work."
- ↳ "Lower costs to offer cheaper fares."
- ↳ "If substitution is the end-result, long-term strategies have to be adjusted, implying downsizing of future capacity growth strategies."
- ↳ "More frequencies."
- ↳ "Offer attractive, inexpensive package travel deals."
- ↳ "Airlines need to stress other product attributes."
- ↳ "Taking advantage of telecommunications development and integrating these technologies in the airlines' product profile seems to be the most promising response."
- ↳ "Support and promote videoconferences."
- ↳ "Airlines have to go into videoconferencing business."

4.5 M.I.T. Survey among Users of Videoconferencing

This section discusses the results of the survey among videoconferencing managers and individual users in companies conducted for the purpose of this thesis. The questionnaires used in both cases are contained in Appendix 1 and 2 to this study. Parts of both surveys focusing on particular characteristics of videoconferencing use and corporate budget developments have already been addressed in earlier sections; see 2.4.2, 3.6, 3.7, and 3.8. After discussing study methodology and structure, limitations of the approach, and demographics of the survey samples, this section analyzes the evaluations and information given with respect to the interrelationship of videoconferencing and business air travel.

4.5.1 Survey Methodology and Structure

The survey was primarily conducted among companies of the "Fortune 500" group that already use videoconferencing. Some smaller and mid-size corporations were integrated into the survey through pointers by consultants and analysts. Almost all videoconferencing and telecommunications managers provided with the two questionnaires were contacted personally. Only companies stating their willingness and the possibility to participate in both surveys were provided with the corresponding questionnaires. Although all managers were reminded at least once by phone to return the questionnaires, only 26 out of 85 videoconferencing managers initially provided with the survey material responded (31% response rate). In addition, 25 responses by individual users were received. Since the distribution of the user questionnaires was done by the videoconferencing managers, no relative rate of response can be determined.

However, due to time constraints on the analysis of the survey results and the completion of this paper, only 23 responses of the videoconferencing managers (27% response rate) and 18 responses of individual users could be considered in the final assessment of the results.

The low response rate, primarily due to lacking motivational incentives for videoconferencing managers and particularly individual business people, inhibits the recognition of industry- or user-group-specific trends and characteristics. Therefore, the following analysis has to concentrate on the identification of industry-wide user characteristics, adoption patterns, perceived benefits and limitations of videoconferencing use, and experiences and evaluations as regards the appropriateness

of substituting traditional forms of physical face-to-face meetings by videoconferencing.

Before designing the questionnaires, interviews were conducted with industry analysts, consultants, vendors, and users to identify areas of interest for such a survey and attributes and aspects that are possible to be assessed. However, besides these interviews, the choice and phrasing of items integrated in the final questionnaires were also oriented on some prior research, allowing comparisons of survey results with earlier findings. Before deciding about the final version of the questionnaires, drafts were evaluated by people with experience in the conduct of surveys.

Structure of Corporate Questionnaire

The corporate questionnaire (see Appendix 1) was designed for people in charge of videoconferencing systems in a company, usually videoconferencing or telecommunications managers (see section 4.5.3), in order to get information and evaluations on behalf of a corporation.

After giving information about personal job function, degree of responsibility with respect to videoconferencing, and company (type of industry, number of employees, and sales), managers were asked about current use, future plans, and applications of videoconferencing in the company (questions 3, 4, and 5). The relationship of videoconferencing and business travel, containing the assessment of the substitutability of certain business purposes, the role of travel in the investment justification, observations of the travel impact, expectations with respect to future impacts, and evaluations of the stimulation potential, was the subject of question 6. Corporate travel budget trends were evaluated in question 7. Finally, potential benefits of videoconferencing and satisfaction with specific criteria were rated in question 8.

Structure of User Questionnaire

The user questionnaire (see Appendix 2) was designed for individual videoconferencing users in corporations having experience with this technology.

At the beginning of the user questionnaire, introductory information about job function and personal responsibility, as well as about the industry type the company belongs to were asked. Question 3 addresses the personal use of videoconferencing as regards familiarity with the technology, systems most frequently used, frequency

of use, typical participation and duration of videoconferences, and purposes of use. Business travel is subject of question 4, asking for information about main purposes and frequency of traveling, expenses of business travel, and recent and expected future budget trends. The assessment of the substitutability of certain business meeting purposes, changes in business travel frequency since using videoconferencing, and quantifications and evaluations of the impact on personal business travel needs are surveyed in question 5. As in the case of the corporate survey, the questionnaire ends with an overall assessment of videoconferencing, looking at potential benefits, satisfaction, problems and limitations, and the effectiveness of videoconferencing as regards different activities that take place in in-person meetings.

4.5.2 Critique and Limitations of Approach

The chosen approach for the purpose of this survey is associated with several deficiencies that should be addressed and need to be considered in the interpretation of the results.

Subjectivity of Telecommunications and Videoconferencing Managers

Telecommunications and videoconferencing managers were selected as a survey sample since they are usually the most competent group in a company to answer videoconferencing-specific questions on behalf of a corporation. However, it has to be considered that these managers might be highly subjective in their judgment and probably interested in supporting the role of videoconferencing in their company.

User Survey

Several problems are specifically associated with the survey of individual businessmen and women using videoconferencing.

At first, company policies may have constrained the distribution of external questionnaires and the release of certain information.

Second, the reliance on videoconferencing managers with respect to the distribution of the user questionnaires represents a considerable problem. Time and interest of these managers might have decided whether and to what extent forms were distributed to the users. Furthermore, telecommunications people might tend to shield certain users in order to hide criticism, and choose those that have a positive personal attitude toward videoconferencing. Although our interest in a

representative sample of users was stressed in conversations with the video managers, we had only a small influence on the selection of departments and people of different management categories, levels of experience, and personal preferences and acceptances.

For this reason, a more promising approach might be to directly contact departments and user groups in a company if the firm is willing to cooperate and provide access to these groups. Another attempt to receive more specific information and data about the adoption to videoconferencing and experienced and expected travel impacts would be a case-study approach. Instead of an industry-wide survey as in our study, only a few companies would be selected. Through interviewing and cooperating with telecommunications, videoconferencing and travel managers and individual users, as well as through access to travel statistics, applications of videoconferencing in a company, existing acceptance of this technology, preferences of meeting media, and interactions with traditional travel patterns may be more systematically and specifically examined.

Also, the motivation of individual users of corporate videoconferencing to respond to the questionnaire might have been rather low. While videoconferencing managers could at least be motivated with the offer to receive a copy of the executive summary of this study, no motivational incentives could be provided to the individual users. In several cases, videoconferencing managers reported that they had recently performed internal surveys of their users, a fact that might additionally have lowered the incentive to respond.

Length of Questionnaires

The survey was often criticized as being too lengthy, also by videoconferencing managers and users who responded. However, the complex nature of the issues, as well as the limited amount of data available and accessible for this thesis have induced a need to receive a certain amount of information and evaluations through the questionnaires.

Focus on Large U.S. Corporations

The survey concentrates on companies of the "Fortune 500" group and, therefore, in most cases, on the earliest and most experienced adopters of videoconferencing in the business community. However, their experiences, adoption patterns, preferences, acceptances, and evaluations do not have to reflect those of

the general market, particularly of new adopters. On the other hand, experience with the technology allows information and assessments that are more solidly based compared to companies having recently adopted to videoconferencing. In the latter case, evaluations are more likely to be based on speculative judgment and to reflect expectations and assumptions made for the recent investment justification rather than "real world", long-term experience.

Focus on Users

From several interviews conducted for the purpose of this survey and from prior research, it is apparent that even within the "Fortune 500" industry group, a large number of companies still do not use videoconferencing. Several companies contacted also stated that they currently are not considering such an investment. There are even examples where videoconferencing was abandoned after intermediate use due to the recognition that business needs the technology had been adopted for could not be fulfilled.

The integration of non-users of videoconferencing might have provided a more balanced view of the industry's and business community's acceptance of video technology and preferences as regards business communications, as well as of the role of videoconferencing as travel substitute or complement.

Substitution versus Stimulation

The survey integrates both substitution and stimulation of travel by videoconferencing. However, questions with respect to both potential impacts on travel had to be adjusted to the ability of the videoconferencing managers and individual users to provide answers. Knowing about the significance of travel savings for a company, questions were targeted on receiving existing evaluations and quantifications of travel substitution, especially with respect to its role in the justification of investment in video facilities.

Overall, questions dealing with the substitutability of physical business meetings involving travel by videoconferencing clearly outweigh questions addressing the stimulation effect. This derives from the difficulty to assess such complementary interactions. A question like: "Which business trips you are doing today would have not been possible without videoconferencing?", does not seem to be likely to yield an answer. There are no tracking schemes in companies to provide information

about that, contrary to tracking methods used for travel substitution. Also for an individual it is difficult to evaluate this aspect with respect to own travel needs.

A question that would be worthwhile to integrate in such a questionnaire and that is also more probable to be answered is about face-to-face meetings conducted today through videoconferencing that could not have been performed prior to the investment in this technology (the so-called impossible meetings). Today, these meetings may directly replace an in-person meeting. However, since such a meeting would not have occurred without videoconferencing, it cannot be regarded as a travel substitute. There is a need to isolate such meetings from other video gatherings that really substitute for meetings traditionally conducted in-person.

Other more complex impacts of videoconferencing on business travel patterns through changes in the organizational and spatial structure of a company (decentralizing, dispersing) and through competing and cooperating on a wider geographical scale exceed the scope of responsibility and oversight of videoconferencing managers and individual users in a company. Such aspects should have been addressed to people responsible for strategic and corporate planning. However, they are hard to answer since the impact of videoconferencing may be difficult to isolate.

4.5.3 Demographics

In the following, some basic information about sample composition and characteristics of both survey samples, corporate and user survey, are provided.

Corporate Survey

For 57% of respondents to the corporate survey, this survey represented the first time they were asked regarding the issue of videoconferencing-business travel interaction. Ninety percent indicated their interest in the study results.

Job Function and Responsibility

Most of the respondents to the corporate survey described themselves as videoconferencing (43%) and/or telecommunications managers (39%) or analysts (30%) -- note: multiple responses were possible. The majority (52%) explained to be a principal participant in decision-making processes as regards videoconferencing purchase, development and operation in the company. Twenty-two percent are

even final decision makers. Another 22% stated a function in giving recommendation.

Industry Types

Figure 4.5.3-1 illustrates the composition of the survey sample in terms of industry type. The dominant industry sector among the received responses is the computer and electronics industry (34.8%). With each 17.4%, engineering/manufacturing/construction/mining and chemicals/pharmaceuticals are the second largest industry groups in the survey sample.

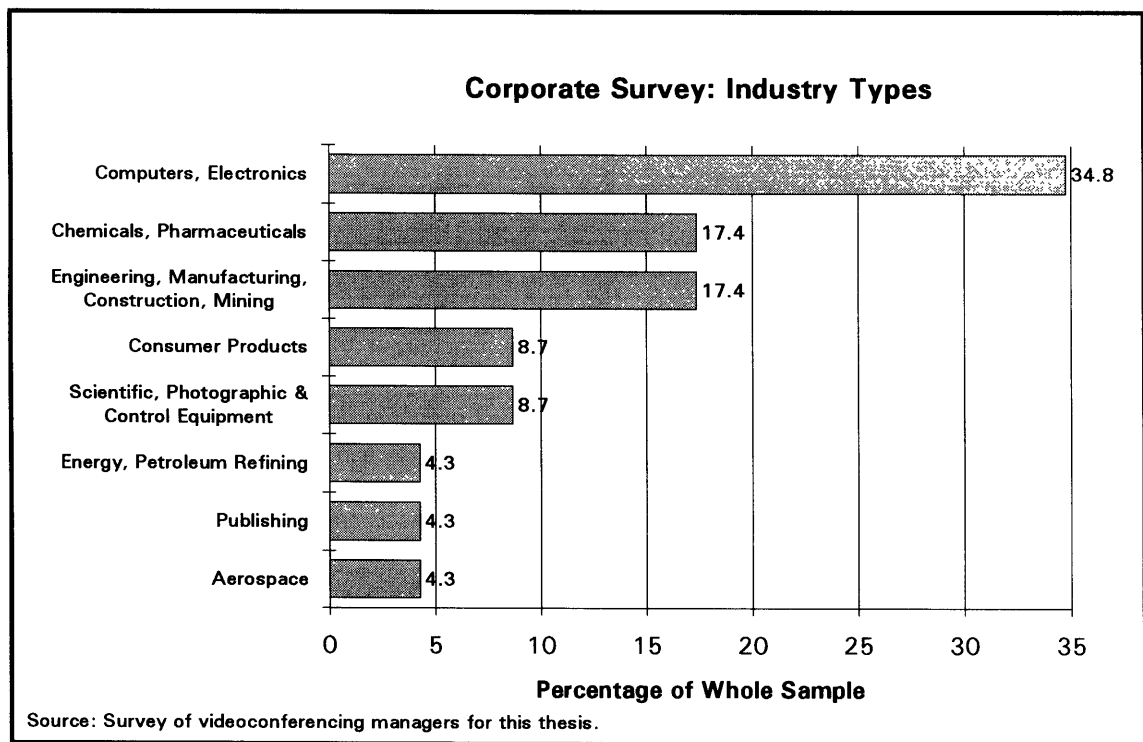


Figure 4.5.3-1: Corporate Survey: Industry Types

Employees and Sites

The average number of worldwide employees of the companies having responded is 38,843. Fifty-seven percent of corporations have fewer than 30,000 employees, while the higher average number derives from some large firms (17%) having a workforce of 80,000 to 100,000 employees. The mean number of employees using videoconferencing in a company is 683 (1.8% of corporate workforce). The average number of worldwide corporate sites is 157, with, on average, 14.5 sites (9.2% of all sites) being equipped with videoconferencing systems.

Sales Revenue

Average sales revenue of the survey sample was \$6.269 billion per company in 1992. The majority of companies (52%) reported revenues below this figure. On the other hand, 17% of corporations stated revenues of \$10 billion to \$20 billion for 1992.

Experience in Videoconferencing

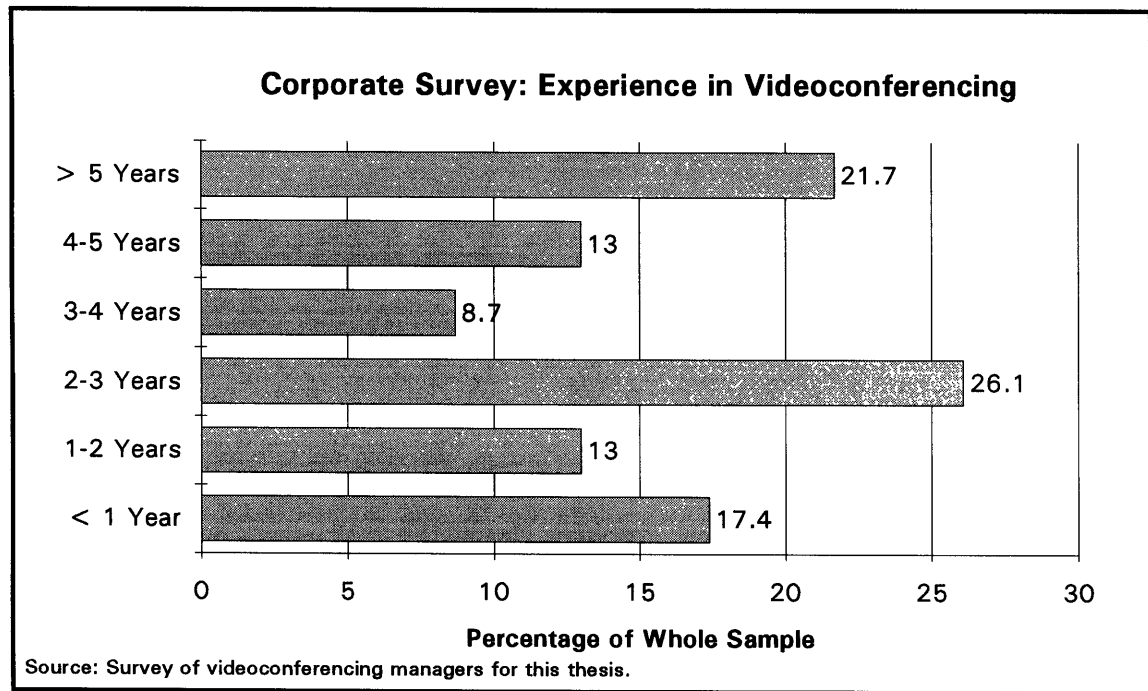


Figure 4.5.3-2: Corporate Survey: Experience in Videoconferencing

Although the focus of the survey was on "Fortune 500" companies, the majority of corporations who responded are not early adopters of videoconferencing (see Figure 4.5.3-2). Fifty-seven percent indicated that their company had been using corporate videoconferencing for less than three years. Seventeen percent explained that they have adopted to videoconferencing as regular users within the last 12 months. On the other hand, almost 22% have been using videoconferencing for more than 5 years. Although the overall sample size inhibits the analysis of industry-specific trends, from the responses received, it can be suggested that the adopters with the longest experience are primarily in the chemical and pharmaceutical industry, and in the computer and electronics sector.

An overview of the systems used by the survey sample, as well as of the utilization of different types of system is provided in section 3.6.3.

User Survey

For 78% of respondents to the user questionnaire, it was the first time that they were surveyed as regards the issue of videoconferencing versus business travel. Since this question is not limited to external surveys, the result suggests that the level at which companies try to monitor the impact of videoconferencing on travel through internal user surveys might be rather low.

Job Function and Responsibility

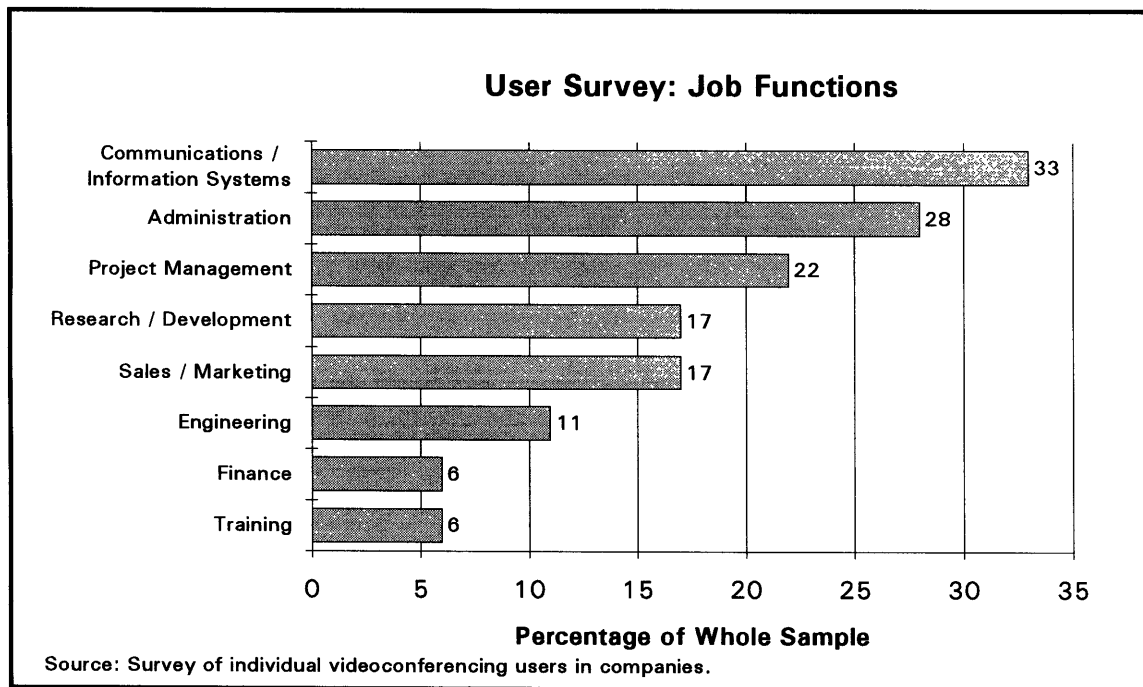


Figure 4.5.3-3: User Survey: Job Functions

Figure 4.5.3-3 illustrates the composition of the user survey sample by job functions. It must be considered that multiple responses were given. The fact that several videoconferencing managers also answered this part of the industry survey as users of videoconferencing is apparent in the sample composition. One out of three respondents works in the communications/information systems area. The next largest groups among the respondents are administration (28%) and project management (22%). No responses were received by users in the areas of production/manufacturing, customer service, consulting, and recruiting.

Almost two thirds of respondents described themselves as middle managers. The rest named its responsibility level in the corporate hierarchy either as lower

management, or as analyst or videoconferencing coordinator. No executive or senior manager responded to the survey.

Industry Types

The composition of respondents by industry type is comparable with that of the corporate survey sample (see Figure 4.5.3-1). The largest group (~25%) is represented by the computer/electronics industry. Rather high shares (each 17%) also have the chemical/pharmaceutical industry and the manufacturing/mining/construction area. Other groups in the sample are aeronautics, automobile, consumer goods, publishing, scientific & photographic, and refining and energy.

Familiarity with Videoconferencing

The level of familiarity with videoconferencing was rated on a non-dimensional scale from 1 ("not at all familiar") to 10 ("very familiar"). With respect to the average rating of 8.1, and particularly to the fact that half of the respondents rated their familiarity with videoconferencing at 10, a high level of experience with this technology is apparent for the survey sample. However, this subjective rating of familiarity must be seen in relation to a rather low degree of experience in terms of years using videoconferencing. Sixty-one percent reported to have been using the technology for less than two years; more than half of those have adopted to videoconferencing in the last 12 months. On the other hand, only 22% stated an experience of more than five years. Interestingly, the latter figure derives not from the high share of telecommunications and videoconferencing managers in the sample. Most of those (two thirds) explained to have used the technology for their personal business purposes for less than two years.

Average Participation and Length of Videoconferences

On average, the participation in videoconferences (cumulated over all sites) conducted by the respondents to the survey is between six to seven conferees. Forty-four percent reported an average participation of three to five persons, while 17% stated that their videoconferences, on average, involve more than 10 persons.

The average length of videoconferences of the survey sample is 1.5 hours. However, 22% reported an average duration of only 30 to 60 minutes; on the other hand, one third stated average video meeting lengths of more than 1.5 hours.

The systems used and types of videoconferencing conducted by users having responded to the survey are subject of the discussion in section 3.6.3.

Business Travel Characteristics

On basis of the total response to the user survey, the average share of business trips that involve air travel is 75% of overall business travel (simple average, no weighting of individuals' travel volume and frequency). For 44% of respondents, the air travel share is 95% to 100%. When doing air travel, 56% normally fly economy class, while 44% most frequently choose business class. This agrees with the observations made in other air traveler surveys that about one out of two U.S. business air travelers flies economy class (domestic & international; see also sections 2.1.2 and 2.4).

4.5.4 Videoconferencing versus Business Travel

The analysis of the survey response in this section focuses on evaluations and information provided on videoconferencing-travel interaction. Responses with respect to current video applications, main user groups, future plans, and overall assessment of videoconferencing benefits, satisfaction, communication effectiveness and obstacles, as well as travel budget trends have been addressed in earlier sections (see 2.4.2, 3.6, 3.7, and 3.8).

The following discussion looks at the role of travel savings in the justification for videoconferencing investment, a comparison of videoconferencing usage and business travel patterns, evaluations of substitutability of travel by videoconferencing for certain business purposes, quantifications of current substitution, assessments of future travel substitution, and evaluations of potential stimulation of travel through videoconferencing.

4.5.4.1 Justification of Videoconferencing Investment through Travel Replacement

Significance of Travel Savings in Investment Justification

The response to questions 6b, c, and d in the corporate survey (Appendix 1) shows that travel cost and time savings are elementary and in some cases even the most significant aspects for the justification of the investment in corporate videoconferencing facilities. Sixty-four percent of companies see travel replacement as a main driver for the acquisition of this technology; eighteen percent evaluate travel savings as definitely the most important aspect. The residual 18% of respondents

explained that travel substitution was of insignificant importance for the justification of the videoconferencing investment in their company.

Quantification of Expected Air Travel Savings in Investment Justification

The companies were also asked about the quantification of expected air travel savings employed in their initial investment justification for videoconferencing. On average, companies reported to have quantified these travel savings to be 21%. Half of the respondents stated substitution coefficients of 5% to 15%, while 21% of companies reported substitution estimates of 30% to 50%.

In monetary terms, the total business travel savings achieved through videoconferencing were estimated, on average, with \$717,000 per year at the stage of the investment in corporate videoconferencing. Fifty percent of corporations reported quantifications of expected substitution of only \$50,000 to \$200,000. The higher mean value primarily derives from the one quarter of companies reporting substitution estimates of \$1.3 million to \$3.0 million

Follow-up of Expected Travel Impact of Videoconferencing

The majority of companies (58%) reported that the initial expectations (investment justification) as regards travel substitution through videoconferencing have been confirmed through actual observations in the time following the system acquisition. Thirty-seven percent stated to have experienced even higher substitution than initially estimated. On the other hand, 5% have seen less travel replacement as expected.

Tools and Ways of Quantifying Travel Impact for Investment Justification

Most corporations (59%) explained to have used field studies and internal surveys of potential users, respectively, prior to the videoconferencing investment as approach for estimating the impact on travel. Seventeen percent stated to have used analytical models/scenarios (no further information provided as regards those) whereas 28% admitted to have based their estimates on qualitative judgment.

For the purpose of field trials and surveys, potential users were primarily asked about their personal travel records and the substitutability of certain trips and meeting forms by videoconferencing. Some pilot projects (three to six months) prior to the final investment decision provided businessmen and women with an opportunity to give more informed assessments. Observations made with respect to

changes in travel patterns during such pilot projects served as orientation for substitution estimates in the investment analysis. Furthermore, company-internal travel statistics between certain sites were used to identify areas of high meeting needs, where videoconferencing might be able to significantly save travel dollars.

Different cost-benefit methodologies were used for the investment justification - self-created, or "standard" approaches by vendors or consulting firms. However, almost all were based on cost trade-offs between travel and videoconferencing. These financial analyses, in most cases, were not performed on a company-wide basis. Justifications were made on project-basis or by individual corporate divisions, using corresponding travel statistics and substitution estimates. Several companies stressed in their response that travel time is the big issue in these saving quantifications, not out-of-pocket expenses for travel.

Only two out of the 23 responses considered in this analysis explained that they do not justify videoconferencing with travel replacement. Their investment justifications are based on more strategic benefits associated with videoconferencing use (see section 3.8.1). However, sufficient information about the way of quantifying these strategic benefits was not provided in the responses.

4.5.4.2 Comparison of Patterns of Videoconferencing Usage and Business Travel

Frequency of Videoconferencing Use and Business Travel

In addition to the small sample size, looking at the patterns of use of videoconferencing and of business travel by the respondents to the user questionnaire (Appendix 2; user survey: 3e, 3f, 3i, 3j, 4a, 4b, 4e, 4f, 4g, 4h, and 5c) reveals that the sample is only limited appropriate to claim any empirical support for a characteristic interaction pattern between videoconferencing and air travel. Frequent business air travelers are widely assessed as being most sensitive to videoconferencing-related travel substitution and, therefore, represent the type of business travelers of prime concern for the airline industry. Table 4.5.4.2-1 shows that almost two out of three respondents travels only very sporadically. The other 38% explained to travel, on average, up to 4 times per month.

From average annual expenses on business travel of \$14,000 in 1993 (or last 12 months) and average costs per trip (including flight, transfers, lodging, meals, etc.) of \$1,650, it can be derived that the survey respondents, on average, made 8

to 9 business trips in 1993 (or last 12 months). This can be seen as a low average for travel frequency and volume.

Table 4.5.4.2-1: Current Level and Changes in Frequency of Videoconferencing Use and Business Travel

Frequency of Use of Videoconferencing and of Business Travel		
	Videoconferencing	Business Travel
<i>daily</i>	25%	-
<i>a few times per week</i>	25%	-
<i>once per week</i>	12.5%	-
<i>a few times per month (up to 4 times per month)</i>	25%	38%
<i>only very sporadically (less than 10 times per year)</i>	12.5%	62%
Changes in Frequency of Use of Videoconferencing and of Traveling in Last 2 Years		
	Videoconferencing	Business Travel
<i>significantly increased</i>	71%	7%
<i>slightly increased</i>	23%	33%
<i>no real change</i>	-	27%
<i>slightly decreased</i>	-	20%
<i>significantly decreased</i>	6%	13%

Changes in Travel Frequency Since Using Videoconferencing	
	Business Travel
<i>significantly increased</i>	0%
<i>slightly increased</i>	6%
<i>no real change</i>	50%
<i>slightly decreased</i>	31%
<i>significantly decreased</i>	13%

Note: Percentages in table indicate the portion of respondents having reported the specific videoconferencing usage and travel frequency, respectively.

Source: Survey of videoconferencing users conducted for this thesis (Appendix 2).

On the other hand, the sample contains frequent users of videoconferencing. Fifty percent of respondents use this tele-medium daily or a few times per week. Only one out of eight stated a very sporadical use of videoconferencing.

The significant deviations in frequency of videoconferencing use and business travel and the high portion of very frequent videoconferencing users suggest that a considerable amount of today's videoconferences represents new types of face-to-face meetings of a frequency not possible prior to the investment in this technology (full reliance on travel). Therefore, the clear majority of videoconferences conducted by the survey respondents represents an upgrading of conventional telecommunications or new face-to-face meetings (the former impossible meetings), rather than a substitution of original business air travel.

Changes in Frequency of Videoconferencing Use and Business Travel

Almost all videoconferencing users reported an increase in their frequency of use of videoconferencing in the last two years; in 71% of cases, it was even described as significant. On the other hand, only 40% experienced an increase in travel frequency in the same period of time. One out of three reported a decline in traveling. Thirteen percent described this decrease as significant.

Even more negative with respect to business travel is the assessment of the change in travel frequency since using videoconferencing. Forty-four percent of respondents experienced a decline in travel. Only 6% reported a slight increase in business travel needs (see Table 4.5.4.2-1).

Purposes of Use of Videoconferencing and Business Travel

On basis of the user responses, an average composition of videoconferencing and travel by regional aspects and business purposes can be determined. The values provided in Table 4.5.4.2-2 represent simple averages derived from the percentages given by the respondents.

Long-distance domestic meetings dominate in both videoconferencing and business travel purposes. More than half of videoconferencing meetings conducted by the respondents to the user survey are over long distance in the U.S. The comparison of videoconferencing and travel patterns also reveals that regional and short-haul applications are under-represented in the videoconferencing composition. Although nearly 40% of face-to-face meetings involving travel are domestic/regional, the need for such meetings via video is clearly lower in relative terms. The comparison of short-haul/regional and long-haul domestic video applications and travel needs confirms the trends identified in section 4.3 (Cost-Benefit Analysis) and in prior research (e.g., Schuler 2/1992). On a domestic basis,

videoconferencing becomes increasingly favorable with increasing distance. For near-by meetings (regional, short-distance), the lower unproductive time of traveling and lower out-of-pocket travel costs imply a more favorable trade-off for travel. This may be the reason for the lower significance of regional meetings in overall videoconferencing applications compared with the relative importance of this meeting form in the overall face-to-face communications requiring physical presence.

In the international area, videoconferencing applications for meetings with Europe have the highest share (10% of total applications) and, therefore, are over-represented in their relative importance compared with the business travel distribution. When doing international travel, two out of three trips by respondents to the survey are transpacific (12% of total trips). Explanations for the divergence in the relative composition of international videoconferencing and business travel might be the lower cost of transatlantic videoconferencing transmission, the wider access and availability of video connection opportunities to Europe, or the higher acceptance of videoconferencing as medium for face-to-face meetings in Europe, especially if compared to that in some parts of Asia.

Looking at business purposes reveals the dominance of intra-company meetings in videoconferencing applications and business travel (regarding video applications, see also section 3.6.5). However, the share of this meeting form in total videoconferencing applications (79%) is clearly higher than its relative importance in total face-to-face communications requiring travel (51%). All other business needs are under-represented in the videoconferencing breakdown, compared with their significance in the travel distribution. This applies in particular to conferences and conventions. While almost no video applications for these purposes were reported, about one out of six trips is done for these reasons. Also inter-company video applications still lack in their relative importance behind that in total face-to-face communication needs.

Overall, the results confirm the observations of existing research that videoconferencing appears to be widely accepted for intra-company applications. However, for inter-company purposes and particularly conferences and conventions, limitations are still evident. Those are either of technical nature (interoperability, accessibility to systems by parties), or of social, cultural and psychological nature (acceptance as face-to-face substitute). For these meeting purposes, in-person atmosphere is much more inevitable than for intra-company meetings.

Table 4.5.4.2-2: Purposes of Videoconferencing Use and Business Travel

Regional Characteristics of Videoconferencing Use and Business Travel		
	Videoconferencing	Business Travel
<i>domestic/regional</i>	26%	38%
<i>long-distance domestic</i>	52%	44%
<i>international to Europe</i>	10%	3%
<i>international to East-Asia</i>	8%	12%
<i>international to South/Central America</i>	3%	1%
<i>international to Canada</i>	1%	2%
Business Purposes of Videoconferencing Use and Travel		
	Videoconferencing	Business Travel
<i>intra-company</i>	79%	51%
<i>inter-company</i>	16%	23%
<i>customer support/service</i>	3%	5%
<i>conferences/conventions</i>	0%	17%
<i>training</i>	1%	2%
<i>interviewing</i>	1%	2%

Note: Percentages in table indicate the relative composition by regional application and business purpose averaged over all responses (simple average).

Source: Survey of videoconferencing users conducted for this thesis (Appendix 2).

4.5.4.3 Substitutability of Different Business Trip Purposes by Videoconferencing

Table 4.5.4.3-1: Evaluation of Substitution Potential of Videoconferencing for Different Business Trip Purposes

Meeting Purpose	Corporate Survey	User Survey
<i>Intra-Company</i>	8.1	8.1
<i>Inter-Company</i>	6.6	6.8
<i>Customer Support/Service</i>	4.9	5.6
<i>Conferences/Conventions</i>	4.0	5.4
<i>Training</i>	6.6	7.1
<i>Interviewing</i>	5.7	5.5

Note: The figures in the table indicate the average ratings given by respondents to the survey on a non-dimensional scale from 1 ("no potential") to 10 ("significantly high potential").

Source: Survey of videoconferencing managers and users conducted for this thesis (Appendix 1 & 2).

Videoconferencing managers and individual users in the companies were asked to evaluate the potential of videoconferencing to substitute for different business trip purposes (Appendix 1 & 2; corporate survey: 6a; user survey: 5a). Ratings were given on a non-dimensional scale from 1 ("no potential") to 10 ("significantly high potential").

Table 4.5.4.3-1 illustrates that the assessments given in the two surveys show very similar trends. Intra-company meetings are clearly seen as the trip category with the highest substitutability (average rating in both questionnaires: 8.1). Forty-eight percent of the videoconferencing managers and fifty-three percent of the individual users rated the substitution potential of business trips internal to the company with 9 or 10. Inter-company meetings and training represent the applications with the second largest substitutability by videoconferencing. However, their ratings are at a notably lower level than those for intra-company meeting purposes. Furthermore, the assessment profile of the respondents regarding these meeting forms is much more heterogeneous. For example, 27% of respondents to the corporate survey evaluated the substitutability of inter-company trips with 9 or 10, while the same percentage could be determined for ratings less or equal 4. Trips for training purposes were seen by 21% of respondents as an area having almost no potential to be substituted by videoconferencing (ratings of 1 or 2).

Conferences and conventions are in both surveys seen as meeting purposes with the lowest potential to be effectively replaced by videoconferencing. Particularly, the ratings given by the videoconferencing managers emphasize that (average rating: 4.0; 37% rated it with 1 or 2). Also, customer services and contacts seem to be only to a limited extent substitutable by videoconferencing today.

4.5.4.4 Quantification of Current Travel Substitution

Figure 4.5.4.4-1 shows the distribution of evaluations provided by the videoconferencing managers and individual users with respect to the current percentage of videoconferences directly substituting for business travel in the company and as regards personal business needs, respectively (see Appendix 1 & 2; corporate survey: 6f; user survey: 5b).

Although the assessment profile received for the corporate survey is much more heterogeneous than that for the user survey, where a concentration of substitution estimates between 5% and 15% is evident (47% of responses in this interval), the

average values determined for both survey samples (using center values of substitution intervals for determination of mean substitution coefficients) are almost identical: 18.5% in case of the corporate survey, and 18.4% for the user sample.

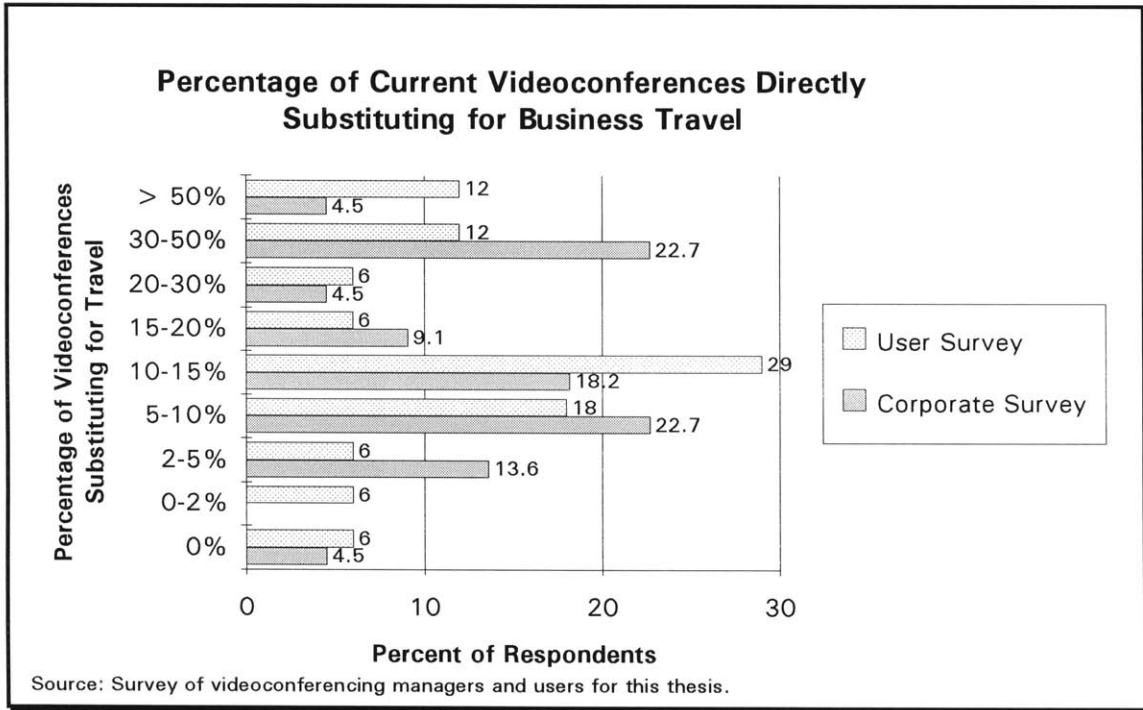


Figure 4.5.4.4-1: Percentage of Current Videoconferences Directly Substituting for Travel

It must be considered that these percentages represent the portion of videoconferences today directly substituting for business travel. They do not necessarily equal the percentage of trips substituted. This phrasing was chosen for the assessment in the survey since the question of the portion of business trips replaced by videoconferencing would contain a larger hypothetical element as regards the volume of travel that would have been made without videoconferencing. The assessment of the percentage of videoconferences today substituting for travel has been judged as more reliably quantifiable.

Though the overall sample sizes actually do not allow the recognition of industry or user group specific trends, two observations should be addressed. Since several videoconferencing managers also responded to the user survey, a masking of evaluations in favor of videoconferencing might have been expected. However, this user group evaluated the current substitution of personal business travel, on average, only with 12%. In the corporate survey, the largest group of respondents, the computer and electronics industry, on average, quantified the portion of video

meetings directly substituting for travel with 9.2% -- significantly below the average substitution coefficient.

As in section 3.8.1, the attempt was made to recognize a correlation of the results with the level of experience in videoconferencing. However, only a weak relationship could be determined, suggesting a slight increase of substitution estimates with increasing level of experience.

Companies were also asked how they would quantify the annual travel cost and time savings due to videoconferencing (corporate survey: 6g). The average of the received responses of \$758,000 in savings per year slightly exceeds the \$717,000 (see section 4.5.4.1) determined as average substitution quantification in the investment justification. The numbers reflect the fact that 95% of respondents explained the observed substitution of travel by videoconferencing in their companies has been as expected at the stage of the investment or even higher. Fifty-seven percent quantified their travel savings at less than \$200,000 while 36% named savings between \$1 million and \$2.5 million.

However, it must be considered that, according to the survey respondents, on average, air travel is only to 46% involved in this travel substitution quantification (corporate survey: 6h).

With respect to the way the impact on travel is measured (corporate survey: 6i), 61% reported that they surveyed corporate videoconferencing users; 22% stated they monitored the development of the number of trips. Nevertheless, only 43% reported to regularly perform follow-up studies on the impact on business travel.

When using internal surveys, users, for example, are asked to fill out forms after a videoconference and to indicate on those whether they would have traveled otherwise, how long this trip would have taken, and how much the travel costs approximately would have been.

4.5.4.5 Evaluation of Future Travel Substitution

Both videoconferencing managers and users were asked about their expectations as regards the percentage of current business travel (of company and personal, respectively) that might be possible to substitute by videoconferencing in the future, supposing current obstacles of videoconferencing use -- e.g., accessibility, video-audio quality, interoperability, ease of use, etc. -- can be resolved (Appendix 1 & 2; corporate survey: 6j; user survey: 5d).

Figure 4.5.4.5-1 shows that the distribution of assessments received is in both surveys rather heterogeneous. However, a concentration of responses stating substitution coefficients between 10% to 30% is recognizable -- 65% of user responses and 67% of corporate responses are in this interval. Based on the center values of the substitution intervals given in the question, average substitution coefficients of 19.9% for the corporate survey and 22.7% for the user survey can be determined. These values are in the order of the average travel substitution estimates reported by the companies with respect to the investment justification and stated to have been observed by most companies afterwards. However, it has to be considered that the substitution estimates for today's air travel in the future are additional to the travel substitution reported by most respondents to be already underlying corporate travel trends today.

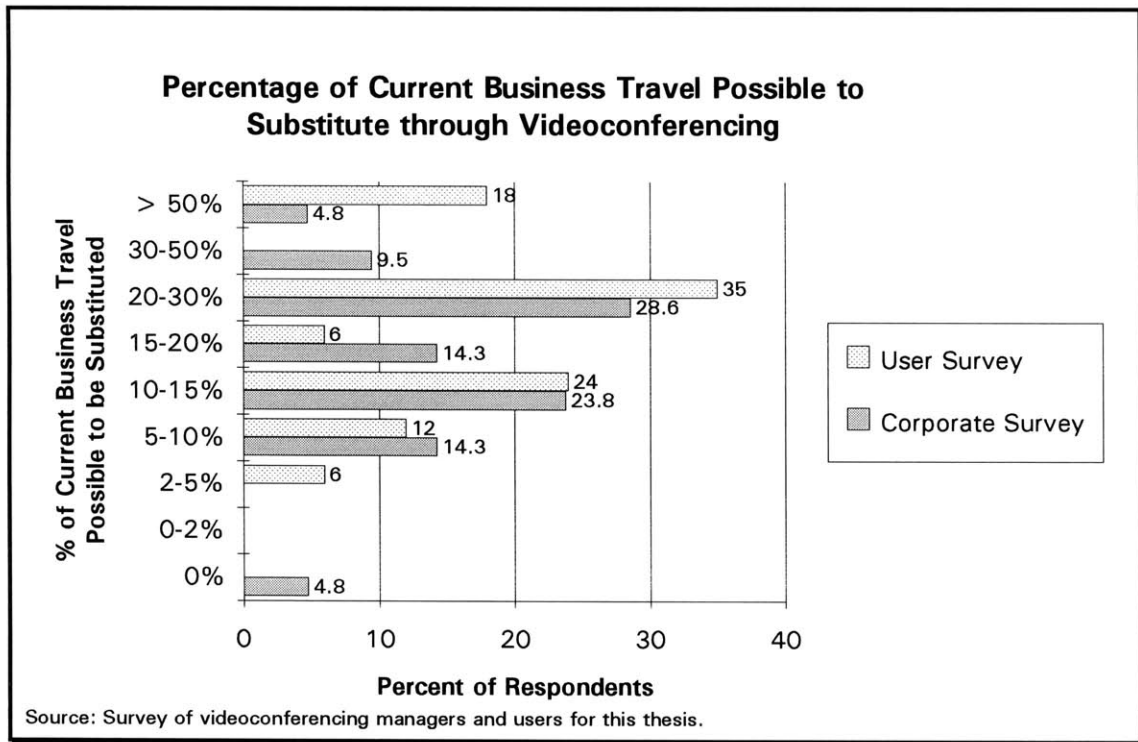


Figure 4.5.4.5-1: Percentage of Current Business Travel Possible to Substitute through Videoconferencing

4.5.4.6 Evaluation of Potential Stimulation of Business Travel

After assessing current and future substitution potentials, participants in both surveys were asked for their evaluations of the potential for stimulation of new business travel as consequence of videoconferencing use (Appendix 1 & 2; corporate survey: 6k/l; user survey: 5e/f). The ratings were given on a non-

dimensional scale from 1 ("no potential") to 10 ("significant high potential"). The results are provided as averages over all responses in Table 4.5.4.6-1.

Table 4.5.4.6-1: Potential of Stimulation of New Travel as Result of Videoconferencing

	Corporate Survey	User Survey
<i>Potential of stimulation of new travel</i>	4.2	4.1
<i>Chance that stimulation offsets substitution</i>	4.0	4.4

Note: The figures in the table indicate the average ratings given by respondents to the survey on a non-dimensional scale from 1 ("no potential") to 10 ("significantly high potential").

Source: Survey of videoconferencing managers and users conducted for this thesis (Appendix 1 & 2).

The rather high figures of current and expected future substitution of travel by videoconferencing have revealed that videoconferencing is primarily seen as a competitive mode to travel. In addition, the assessment of the generation of new business opportunities through videoconferencing as a less significant benefit in comparison to other potential benefits (see section 3.8.1) has already supported the suggestion that the complementary interaction of videoconferencing and travel is widely not observed by the respondents to the survey.

The evaluations shown in Table 4.5.4.6-1 confirm these trends. The potential of videoconferencing to generate new business travel through productivity gains and a wider scope of business opportunities is, on average, assessed as rather low (user: 4.1; corporate: 4.2). In both surveys, about half of the respondents evaluated this potential with 1 to 3. Consequently, the chance that, in the long term, travel stimulation may offset any substitutional effects by videoconferencing experienced today is rated as low, as well. Thereby, the user response reflects an inconsistency since the second question regarding travel stimulation must be seen as an augmentation of the first one. The potential to offset substitution should not be higher than the potential that stimulation of travel as result of videoconferencing occurs at all.

4.5.5 Interpretation of Results

Substitution versus Stimulation

The clear majority of videoconferencing managers and users evaluated videoconferencing as a significant substitution mode for business air travel. The perception of such a competitive interrelationship is expressed in considerably high substitution estimates in the order of 20%, representing the upper bound of the range for substitution coefficients most widely identified in the literature.

Stimulation of business travel as consequence of productivity gains and of the generation of new business relationships is assessed as being of lesser significance and as having a low potential to offset substitution of travel in the long term. This seems to primarily derive from the perception that the generation of business opportunities in general is only an insignificant benefit of videoconferencing use, particularly relative to the other potential benefits.

However, it has to be considered that these evaluations were given from a personal point of view and knowledge. Even, the videoconferencing managers asked to assess the items in the questionnaire from a more global company perspective are not capable to overview the whole complexity of interactions between videoconferencing and travel. The measurability of travel generation due to videoconferencing, particularly in the long term and of indirect nature (globalization of cooperation and competition, access to new markets, decentralizing and dispersing of organizational units, etc.), is barely possible for videoconferencing managers and individual businessmen and women. The complementary interaction between telecommunications and travel is difficult to quantify through videoconferencing user surveys and monitoring of travel and videoconferencing usage patterns between particular sites. Current means to track the impact on travel are concentrated on substitution and are incapable of providing basic data for the complementary relationship. An integration of assessments by strategic and corporate development managers might be important and more promising with respect to long-term telecommunications-travel interactions.

Investment Justification

The majority of companies explained that travel cost and time savings were a main or even the most significant factor underlying the investment in videoconferencing facilities. The investment justification, in most cases, was primarily based on travel replacement quantifications. This result confirms observations and evaluations of researchers and analysts discussed throughout the previous sections. Also, the quantification of travel savings of, on average, about 21% lies almost in the range suggested in most other studies (10% to 20%).

Assessment and Quantification of Today's Substitution

Although several experts, researchers, and users claim that travel substitution is often only initially the key objective of videoconferencing adoption and primarily

because of its simpler quantifiability used in most investment analyses, but with increasing time of usage only of minor significance relative to other benefits that become more driving factors (see sections 3.6, 4.1.3, 4.2, and 4.4), this view is not shared in the surveys for this thesis.

Ninety-six percent of companies reported that they have observed the level of travel substitution expected at the stage of the investment or even more. Furthermore, travel substitution together with increased communication flexibility is seen as the most significant benefit of videoconferencing (see section 3.8.1).

In most cases, these figures are derived from internal user surveys and monitoring of travel between sites using videoconferencing. These numbers might apply to the development of the travel volume of individual users, user groups, sites, or for certain projects. When considering that, on average, only 9.2% of all corporate sites are equipped with video facilities and only 1.8% of all employees use videoconferencing, the impact of such specific occurrences of travel substitution on overall corporate travel budgets and volumes should be definitely lower than the average substitution coefficient of around 20% derived from the survey response.

In addition, it is important to consider that the companies reported that air travel constitutes only 46% of total travel substitution quantification (on average: ~20%; ~\$750,000 annual savings). This implies that a significant amount of substitution of business travel occurs on a regional and urban basis involving travel by car and, to a lesser extent, by rail. According to the user survey, on average, regional business travel contributes for 40% of total business travel, probably to a considerable extent not involving air travel.

The substitutional impact of videoconferencing on the travel needs of survey participants is also apparent in the result that 44% experienced a decline in travel frequency since using videoconferencing, while only 6% stated the opposite.

According to the user survey, one out of five videoconferences directly substitutes for business travel. The other 80% are an upgrading of conventional telecommunications media or a meeting form that did not occur prior to the availability of videoconferencing.

Substitutability of Business Air Trips by Purpose

Intra-company applications clearly dominate in the overall composition of videoconferencing meetings by business purpose. This type of face-to-face meeting is also assessed as having the highest potential to be substituted by videoconferencing. Inter-company meetings and especially conferences/conventions external to the company are still under-represented in total video applications with respect to their significance in overall face-to-face meetings by the survey respondents. This applies to a lesser extent also to customer services, training, and interviewing.

Table 4.5.5-1: Substitutability of Business Air Travel by Purpose

Business Air Travel Purpose	Break-down of Business Travel of Survey Sample	Rating of Substitutability	Quantification of Substitutability Rating¹	Weighted Average Reduction in Number of Trips by Purpose (Survey)	Break-down of Total U.S. Business Air Travel (1988)²	Weighted Average Reduction in Number of Trips by Purpose (U.S. Bus. Travel)
<i>Intra-company</i>	51%	high	25%	12.8%	14%	3.5%
<i>Inter-company</i>	23%	moderate-high	20%	4.6%	15% ³	3.0%
<i>Customer Services</i>	5%	moderate	15%	0.8%	25% ⁴	3.8%
<i>Conferences</i>	17%	low-moderate	10%	1.7%	15%	1.5%
<i>Training</i>	2%	moderate-high	20%	0.4%	15%	3.0%
<i>Interview</i>	2%	moderate	15%	0.3%	2% ⁵	0.3%
<i>Other⁶</i>	N/A	N/A	15%	N/A	14%	2.1%
Total	100%	-	-	20.6%	100%	17.2%

1: Average non-dimensional ratings given by respondents with respect to substitutability of different trip purposes are transferred into percentage quantifications so that total reduction of business travel equals average substitution potential expected by respondents for the future (19.9% - 22.7%).

2: From U.S. Travel Data Center (Arthur D. Little 1991: 29-30).

3: Inter-company meetings.

4: Consulting, selling a product or service, or other professional advice.

5: Estimate, based on survey; not specified in data of U.S. Travel Data Center.

6: The substitution rating for this category was not assessed in survey; the 15% are a subjective guess.

Source: Survey of videoconferencing managers and individual users for the purpose of this thesis (Appendix 1&2).

The rather high ratings for substitutability of inter-company meetings and training purposes confirm results of prior research, suggesting a trend toward more

video applications for these purposes, especially in the area of inter-company relations, where obstacles as interoperability, network connection opportunities, and social and psychological acceptance are diminishing. On the other hand, the survey results suggest that customer services and conferences/conventions seem to remain insignificant for video applications and only marginally sensitive to travel substitution.

Also the assessment of potential substitution of current business travel by videoconferencing in the future -- supposing a diminishing of existing obstacles on videoconferencing use -- of around 20% (on average: 19.9% in corporate survey, and 22.7% in user survey) confirms most of the prior research and survey results.

On basis of the average composition of business travel in the user survey sample and the rating of substitutability of business trips by type, the assessment of the future substitution potential of business travel is used to estimate the substitution coefficients for each meeting category (see Table 4.5.5-1). When applying these estimates to the composition of U.S. business air travel (U.S. Travel Data Center; Arthur D. Little 1991: 29/30), an estimate for the overall U.S. business air travel substitution potential by videoconferencing of 17.2% can be determined.

Though these results are in the range of estimates widely supported in the existing literature, we do not claim any empirical proof or evidence for such a level of substitution. This derives not only from the limited sample size and representativeness. Several aspects need to be considered: The quantification of potential business travel substitution by videoconferencing in the future is based on the assumption that current obstacles in usage can be resolved or at least minimized. Yet, there is no evidence that all existing barriers for video applications can be solved, especially with respect to cultural, psychological and social acceptance limitations. Additionally, it has to be considered that technological innovations and their impacts on economy and society are neither immediate, nor complete. Therefore, the assumption of the accomplishment of a "final" maximum potential of air travel substitution is questionable.

With respect to regional factors, the survey results suggest that the long-haul domestic air travel market is most sensitive to videoconferencing. Here, clearly most video applications can be found. Regional videoconferencing is still under-represented as regards the relative importance of this type of face-to-face gathering

in the overall communications volume requiring physical presence. Since travel substitution is not limited to air travel (on average: 46% of total travel substitution quantification by companies, and 75% of total business travel by users), particularly in the regional and short-haul area, travel replacement seems to heavily involve surface transport by car or rail. On the international basis, European air travel appears to be most susceptible to videoconferencing substitution. Transpacific video applications are still under-represented with respect to their relative importance in overall face-to-face communications.

Overall Limitations of Results

As discussed earlier in the study, hypothetical questions as regards future adoption behavior, in general, lead to an overstating of real impacts (see section 4.2.1; Salomon, Schofer 3/1988: 226; Khan 1987: 23). Though assessing certain types of travel as substitutable through videoconferencing, when finally faced with the mode-choice decision, personal preferences and incentives, as well as specific business needs may induce the choice of travel. Therefore, the received substitution ratings and assessments of future substitution potential are probably overly optimistic. Furthermore, it has to be noted that these estimates are given by today's users, with, in many cases, some years of experience in using videoconferencing for business purposes. The question arises to what extent these estimates are transferable to the overall business air travel market.

The portion of business people using videoconferencing today is still very small. Even, in companies using corporate video systems, according to the survey results, the technology is adopted by only a small percentage of the workforce (on average: 1.8%). In spite of existing market projections forecasting an explosive growth of videoconferencing in the near future, accompanied by an increasing penetration into all businesses and management levels, it is uncertain to what extent adoption patterns and experiences reported by current users of videoconferencing are comparable with the usage and adoption characteristics of future videoconferencing users.

And, finally, it has to be addressed that the received estimates of future travel impact do not consider any complementary interactions between videoconferencing and business travel, which, especially in the long term, are very likely to underlie the future development of business air travel, simultaneously to substitutional effects claimed by most users to be already observable.

5 CONCLUSIONS: IMPLICATIONS FOR BUSINESS AIR TRAVEL AND POTENTIAL RESPONSES BY AIRLINE INDUSTRY

This section summarizes the results of the analysis throughout the previous sections and interprets them with respect to their implications for the aviation industry. Furthermore, potential responses to the development in modern telecommunications, particularly in the area of videoconferencing, by the airline industry are addressed.

The following discussion does not provide quantifications of the impact of modern teleconferencing systems on air travel demand as attempted by most of the prior research works (see section 4.2.2.2). The analysis throughout this study has emphasized that the current state of research and the complexity of potential interactions between telecommunications and business travel do not allow the determination of reliable estimates. Any substitution and stimulation estimates that can be found in the literature are weakly based.

5.1 Business Air Travel Trends

U.S. business air travel has seen low average annual growth rates since deregulation of the U.S. airline industry in 1978. Particularly in the recent few years, business air travel demand has been flat. And, most market forecasts project a continuation of these low annual growth rates. However, slow growth of business air travel demand is not only a phenomenon of the U.S. market. Other world markets -- especially the international markets of the U.S. majors as transatlantic, transpacific, and Western European -- are experiencing similar low growth trends, though at slightly higher levels.

Since the pleasure air travel markets, at the same time, show moderate or high growth rates and are expected to retain these trends in the future, the relative share of business travel of total air travel continues to decline. By the year 2000, the percentage of business air travel (world-wide) is expected to be at 25% to 30%, down from today's 40% to 50%.

Increased price sensitivity of the business travel segment due to growing pressure on corporate travel budgets is seen as the main factor underlying these business travel trends. Furthermore, several experts and industry analysts assess

the U.S. business air travel market as an increasingly mature market implying low growth rates in future years.

In addition, the business community has discovered alternatives to traditional business travel: modern telecommunications, particularly videoconferencing. Spurred by travel budget cuts and increased time pressure on decision-making and product development in the competitive marketplace, the efficiency of business travel is now being questioned, and interactive tele-media are increasingly being employed as direct substitutes for certain types of business trips.

5.2 Emergence of Videoconferencing and its Implications for Business Air Travel

The discussion in the previous sections has revealed the complexity of potential interrelationships between telecommunications and travel, and the variety of existing assessments as regards the net impact on business (air) travel. Most experts and researchers agree that videoconferencing has developed from a tactical tool used to save travel dollars to a strategic instrument associated with much more far-reaching business objectives, such as gains in productivity and competitiveness (see section 3.8.1).

However, in times of searching for ways to increase employee productivity and to streamline management, corporate travel costs remain under pressure. Savings in travel are still the main factor in the justification of an investment in videoconferencing, not only because of their simpler measurement and quantification. Prior research and the M.I.T. survey have shown that travel savings are still regarded by users as a prime benefit of videoconferencing and are the benefit most likely to be observed in post-investment analyses.

Even, if companies are pursuing travel substitution through videoconferencing, the analysis of the impact on travel must not be limited to mere travel replacement. Researchers and experts widely agree that travel substitution and stimulation occur simultaneously, and that overall face-to-face communications will increase in frequency and volume after videoconferencing is introduced. If latent demand for travel exceeds the available time and budget, trips substituted by telecommunications will simply free time and budget to satisfy this latent demand for other business travel (Mokhtarian 4/1988: 283; Harkness 1977).

Different arguments can be found as regards the net impact of videoconferencing on business air travel. Do substitutional effects outweigh stimulation, or might the opposite occur? In individual cases, this may depend on company policies toward videoconferencing and travel authorization and budget. In today's state of research, it seems to be impossible to claim scientifically one of these two hypotheses. Much empirical work is necessary, analyzing all potential interactions between enhanced telecommunications and business travel -- in the short and long term, and of direct and indirect character.

The international and U.S. domestic digital data transfer network and the number and nature of servers and users with which connections can be established are continuously growing. Nevertheless, the current level of market penetration and adoption of videoconferencing cannot be expected to induce stable market responses, on which forecasts of future behavior can be made. Only in a few cases, companies have seemed to realize the full scale of benefits and limitations of videoconferencing for their business.

Substitution

Independently whether travel savings are the main driver for a videoconferencing adoption, most studies and surveys -- also the survey for this thesis -- suggest that substitution as the most direct and short-term effect of videoconferencing on travel is most likely to occur. Quantifications of travel replacement are primarily done on a project basis, site basis, or with respect to personal business travel needs of individual videoconferencing users.

However, since the percentage of businesses using videoconferencing as a regular and elementary part of their business activities is still very low, it is widely suggested that the current impact on overall U.S. business air travel is marginal and probably not measurable.

Nevertheless, videoconferencing is continually and dramatically improving in its relative price performance, as well as in its quality and convenience of use. The air travel industry, on the other hand, does not seem to be able to notably improve its competitiveness with respect to these attributes. Most telecommunications industry analysts and consultants expect an explosive growth of the videoconferencing market in the future, characterized by a penetration into all business areas and management levels. While developing into a commonplace business instrument, videoconferencing will prove its communication effectiveness and appropriateness

for a wide range of business applications. Videoconferencing is enhancing its competitive edge in competing with business air travel for the same types of demand: businesses in need of interactive face-to-face communications among people in geographically dispersed locations.

Existing research, as well as the videoconferencing survey for this study reveal that experience with videoconferencing causes companies and individual users to evaluate videoconferencing as a significant short-term substitute for business travel (on average: 10% to 20% replacement). Several studies, especially the most recent studies focusing on telecommunications-air travel interrelationships, use these estimates by experienced users to project the impact on future air travel growth and demand for new aircraft capacities. However, these forecasts appear to be not appropriate for a sound air transportation planning. Their empirical proof is lacking, and their approaches are biased by their exclusive focus on travel substitution. Furthermore, even if a dramatic market growth in the videoconferencing area is projected, it is not known whether, when, to what extent, and how businesses will adopt to videoconferencing in the future and what impacts the adoption to videoconferencing will actually have on business air travel in the longer term.

The application of estimates of substitution and substitutability given by current videoconferencing users, which today represent only a minor portion of the total business community, to future potential adoption and travel patterns and to the whole segment of business air travel is questionable. Furthermore, it needs to be considered that assessments of travel substitutability by videoconferencing are often gained from attitudinal surveys whose results are likely to overstate the "real" impact of videoconferencing.

Stimulation

Stimulation of travel by enhanced telecommunications is much more complex in its occurrence and measurability. Reasonable arguments in favor of the theory of travel stimulation have been provided throughout this study. However, contrary to substitution, which is at least observable on a project basis by companies, empirical evidence for stimulation is not existent.

The capability of videoconferencing to expand and intensify existing business relations and generate new business opportunities of wider geographical scope associated with new travel needs is claimed by several researchers and analysts. As well, it is suggested that there will be other business trips that become feasible

due to gains in employee productivity and efficiency by using videoconferencing for certain applications (the idea of a constant personal business travel time budget). However, these theories are insufficiently supported by empirical evidence. Also in the survey for this thesis, the capability of videoconferencing to generate new business relations and, therefore, directly stimulate travel is assessed as minor.

The area of travel stimulation as a consequence of videoconferencing represents an extensive potential for future research, especially in need of empirical examination and of the development of sound analysis schemes.

Streamlining

Reasonable arguments can also be found regarding the theory that increases in managerial productivity through videoconferencing may promote the rationalization of workforces and the downsizing of management. In such cases, personal productivity enhancements inducing new travel opportunities may be washed out by these company-wide organizational trends.

Substitution of Other Firm's Business

A similar interaction is claimed on a macroeconomic basis. Increasing competitiveness and geographical scope of business activities of a single corporation may simply substitute for business activities and projects originally conducted by other companies. For example, a marketing consultancy in Boston may lose its client in New York City to a consulting firm in Los Angeles that is capable to interact through videoconferencing in the same frequency face-to-face with the client in New York as the competitor in Boston used to do. While the consulting activities originally might have involved weekly travel between Boston and New York City, the new situation may require only one monthly business trip. With respect to current fare levels in both markets, this substitution of one form of travel by another could be even favorable in terms of total revenue for the airline industry. However, in many cases, such a trade-off would be highly disadvantageous.

Changes in Organizational Structure and Locational Characteristics

More hypothetical than the short-term stimulation effects of videoconferencing on business travel are the potential long-term interactions between this technology and business air travel. On a national and global scale, increased flexibility and

freedom in the choice of organizational structure, and in the location of white collar office activities provided through the availability of enhanced telecommunications technology lead to decentralizing of businesses on an increasing geographical scale. Corporate units become independent of the location of other company facilities. In addition, proximity to customers and suppliers can be better realized. Since face-to-face meetings remain inevitable -- in spite of heavy reliance on videoconferencing and other multi-media applications --, new business travel is generated, which was not practiced before when certain forms of cooperation among units were "building-based" at the same location.

Also, dispersing of offices within a company into smaller units may stimulate the growth of small peripheral business centers. Videoconferencing may contribute to the development of business with and among these minor centers, a trend that is likely to produce new air travel patterns for commuter and regional air traffic.

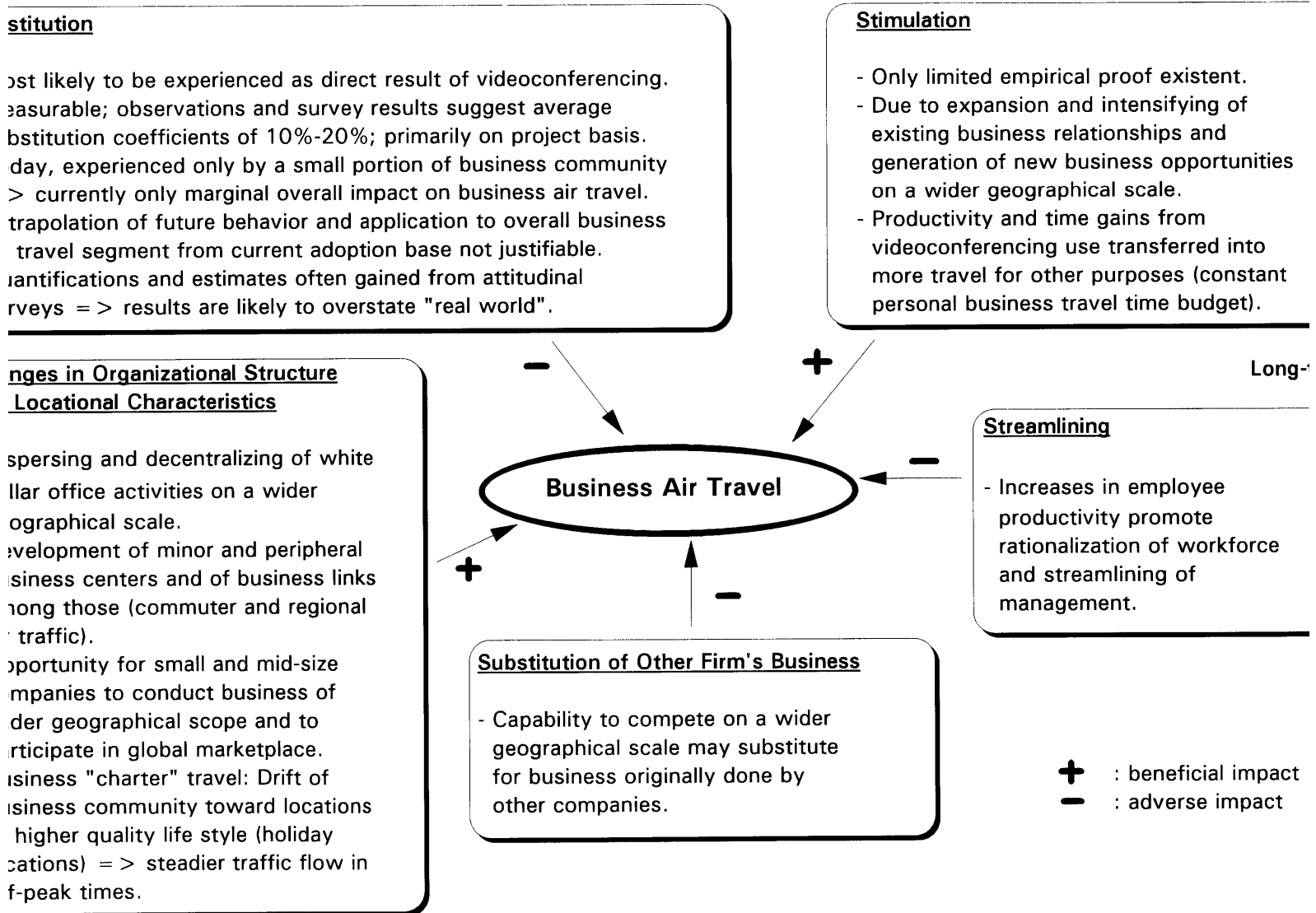
Videoconferencing is also likely to create opportunities for small and mid-size companies to promote and conduct business on a wider geographical scale. Particularly, if these businesses are not centrally located, videoconferencing encourages links with remote customers and suppliers by lowering the threshold at which business can be followed up cost effectively. Therefore, modern telecommunications are likely to broaden the base at which business is conducted and to stimulate the need for business traveling (Brebner 1994: 8/9).

A further interesting scenario is designed by Brebner (1994: 8). Decentralization of business through videoconferencing and other interactive multi-media applications may induce a drift of business toward more attractive regions in pursuit of higher quality life styles. As result, the existing demarcation between pleasure and business travel is likely to diminish in these markets. A growing number of locations of recreational appeal will attract business people in off-peak seasons. Such "holiday" locations attracting growing business communities may produce a steadier traffic flow to and between them, particularly in off-peak times. With respect to the European air charter market, Brebner calls this scenario "off-peak charter flights to the business world".

Figure 5.2-1 illustrates the various possible interactions of videoconferencing with business air travel.

Figure 5.2-1: Implications of Videoconferencing for Business Air Travel

Short-1



5.3 Potential Responses by Airline Industry

Although it cannot be proven today that the net impact of videoconferencing on business air travel will be negative for the airline industry since there are several developments very likely to generate new travel in the long term, the airline industry should turn its attention more seriously to this issue. Videoconferencing appears to be capable to compete with traditional transportation modes, such as air transportation, for specific business purposes in particular markets, primarily in the U.S. domestic market and the transatlantic and transpacific markets.

Airlines and aircraft manufacturers should study the matter in detail, before the real impact is likely to arrive. The attempt to head off modern telecommunications in terms of price will not work. Also, a passive response in form of adjusting future capacity planning to weakly founded forecasts of substitution of air travel demand by videoconferencing does not seem to be recommendable. The airline industry should realize that telecommunications also have the potential to complement existing forms of transportation and that it may benefit from this potential if the airlines harness it at an early stage (Brebner 1994: 8). Today, the airline industry has not prepared itself to react successfully to developments in the telecommunications area.

Increasing Productive Travel Time of Business Air Travelers

Airlines should pursue ways of increasing the productivity of business travelers. Unproductive travel time is probably the most crucial factor for the choice of videoconferencing as an alternative to meet someone in-person. Through the further introduction of means of business communications, such as fax, phones, computer facilities, and even videoconferencing, into the airlines' service profile on-ground and on-board, the attractiveness of business air travel can be increased. Even, if this comes at a certain cost, it is an essential service upgrading and may inhibit any preference of videoconferencing to travel by travelers with high values of time.

Airline lounges and airports in general should provide a wider variety of business support services. Videoconferencing centers should be established at airports offering a reduction of unproductive transit and connection times. Such facilities would also represent a fallback service in the event of flight delays or cancellations. For example, the possibility of significant delays or even cancellations during bad weather periods in New England's winter may discourage a businessman or woman from Boston to schedule a meeting in Chicago. However, the knowledge of the

existence of fallback videoconferencing services in case of the non-provision of the desired air services may promote the decision of scheduling the meeting and, therefore, booking the flight. On the other hand, it is legitimate to argue that the provision of such videoconferencing services at airports also incorporates the potential "threat" of allowing people to experience the effectiveness of using videoconferencing for the conduct of specific business meetings, for which travel was actually intended. This may cause the businessmen and women to choose videoconferencing instead of air travel for such meeting purposes next time.

Support and Promotion of Videoconferencing Networks and Services by Airlines

A few responses to the survey of international airlines conducted for the purpose of this thesis, and the paper by Brebner (1994) suggest that the airline industry should identify videoconferencing as a mode of travel, closely associated with the function of transportation in terms of what it can do to bring people together.

Airlines should enter the videoconferencing business, and support and promote network and service development, in cooperation with the hotel industry, which is also concerned with videoconferencing's impact on business travel. Areas of primary focus should be the development of networks and multi-media conference centers in peripheral and minor business centers in order to induce business with and among these centers and, therefore, to spur commuter and regional air traffic to and from these business centers.

Furthermore, airlines and hotels should support videoconferencing centers in major and minor business locations to provide small and mid-size companies with the opportunity to conduct business on a more global basis, which can be followed up cost-effectively by videoconferencing. However, modest entrepreneurs that might have traveled only very sporadically may develop into ones with increased business links of wider geographical scope, associated with an increased need for air travel to the inevitable face-to-face business meetings.

Also, the promotion of videoconferencing networks and services at traditional pleasure travel locations may have the positive effect of producing business communities there and inducing new forms of combined business-pleasure air travel. This may lead to more steady traffic to and between those "holiday" centers in off-peak periods.

Videoconferencing as Enhancer of Productivity and Competitiveness of an Airline

Finally, it has to be addressed that videoconferencing is also an effective tool for increasing the internal productivity of the aviation industry and that it offers a potential for cost cutting and increased service quality at the same time.

Boeing and other aircraft manufacturers and suppliers are already experiencing the benefits associated with using videoconferencing and computer conferencing applications for research, development, and design projects involving teams (internal and external to company) in geographically dispersed locations.

Videoconferencing in combination with other multi-media applications offers an airline the opportunity to provide various travel consultancy services from a central location to a broad range of customers and to upgrade the retail network (automatic booking, ticketing, money transfer arrangements, and personal customer service; Brebner 1994: 9).

6 FUTURE RESEARCH OPPORTUNITIES

The discussion throughout the previous sections has shown that the field of telecommunications versus business air travel offers extensive research opportunities.

Empirical Research

Empirical proof is lacking for different theories of interaction between enhanced telecommunications and air travel as developed by experts, researchers, analysts, and industry participants in both the telecommunications and aviation industry. Such empirical research has to consider all potential interactions from short-term direct travel substitution to long-term indirect stimulation and modification of business travel patterns.

Studies may be done in form of industry-wide field trials including a representative sample of corporations of different industries and businesses, different levels of experience with videoconferencing technology, and with business activities of different geographical scope. The sample size should be considerably larger than in the case of the survey for this thesis and, in addition to the U.S. market, should also comprise East Asia and Europe in order to identify similarities and differences in adoption patterns among these regions, and in order to be able to derive results more relevant for the global business air travel market. In order to develop long-term time series and to identify changes in adoption behavior, communication preferences, and corporate travel patterns, such user surveys have to be carried out in regular time intervals.

Another promising approach may be a more case-specific research focusing on a few companies and allowing a much more detailed and disaggregated examination of videoconferencing adoption by different user groups and its impact on business travel needs.

The empirical research has to be focused on videoconferencing usage patterns, acceptance and perceived effectiveness of communication via videoconferencing for certain business meeting purposes, the value of personal contact, the perceived benefits and limitations of videoconferencing, and the consequences of these benefits, limitations, and communication preferences on the need for business traveling.

Since sole monetary quantifications of telecommunications-travel interactions are not sufficient, means have to be developed to quantify the important non-monetary factors underlying the mode-choice decision between telecommunications and travel and to integrate those with the cost-benefit analyses.

Measurement and Quantification of Travel Stimulation

A lack of measurability and quantifiability is evident with respect to travel stimulation. Even, more direct stimulation effects of videoconferencing through freeing of time for new business activities or generating new business occasions by making information accessible about business potentials and interaction opportunities with distant locations are very difficult to measure.

Surveying videoconferencing users as regards business trips that would have not been done without videoconferencing is not likely to provide sound results. Contrary to the question of what percentage of today's videoconferences is substituting for business air travel, the above assessment of stimulation of travel is hard to identify.

Schemes for tracking the stimulation interaction between videoconferencing and travel have to be developed. For example, if data are available and accessible, an examination of statistical correlations between productivity gains achieved by individual work groups or business units using modern telecommunications technology -- parameters: revenue per employee/unit, revenue per man-hour, profit per employee/unit, time-to-market, business transactions per time interval, etc. -- and business travel demand may be promising. Also, the geographical scope and the provision of new business opportunities as function of the utilization of videoconferencing should be integrated in such an analysis.

Travel Substitution Quantification

The quantification of travel substitution stated by users and researchers has to be carefully interpreted. Even, if particular videoconferences conducted today are perceived as a direct substitute for a face-to-face meeting traditionally requiring travel, the question arises whether such face-to-face communications would have been conducted before videoconferencing was available. In the event of the provision of new face-to-face meeting opportunities, business travel is not replaced but overall business communications expanded. Therefore, a more careful differentiation between videoconferencing meetings substituting for air travel, necessary prior to the investment, and videoconferences providing new communication

occasions or representing an upgrading of more conventional telecommunications, such as fax, phone, or audio teleconferencing, needs to be done in empirical studies.

Value of Personal Contact

The psychological needs and limitations that might restrict the ability to substitute videoconferencing for personal face-to-face contacts involving an element of trust are poorly understood. Yet, little research has been done to either confirm or reject hypotheses suggesting the significance of such psychological and social aspects in the mode-choice decision.

Even, if existing patterns of face-to-face interaction for business purposes are primarily motivated by social conventions, research is needed to understand whether those conventions can readily be altered by experience and economic forces. Current research is widely based on speculations both about how technology will evolve and how human behavior will respond (Schuler 2/1992: 306).

Field Survey

Surveying individual users of videoconferencing in a company should not be done by relying on videoconferencing managers and the distribution of questionnaires to the users through them, as in the survey for this study. People responsible for telecommunications and videoconferencing, respectively, may tend to shield certain users, hide criticism, and prefer individuals known for their positive attitude toward videoconferencing. Furthermore, such a survey should not exclusively be focused on current users but also include businesses that might have already tested and analyzed videoconferencing regarding its appropriateness for different business purposes, but then have judged it to be less beneficial and, therefore continue to rely on travel where interactive face-to-face communication is needed.

Also, business people that are likely to be faced with the choice between both modes in the future but currently are without experience in videoconferencing should be integrated in the analysis with respect to their values of personal face-to-face contacts and unproductive travel time, and their expectations and requirements as regards the use of videoconferencing in business communications.

Case Study Approach

Instead of an industry-wide survey, a more specific case analysis including only a few companies using or assessing corporate videoconferencing may represent a promising empirical approach. On a departmental level, it should be examined how business units utilize videoconferencing, and what effects are observable on their overall business communications and structure, as well as on the need for travel. Also, departments currently not having adopted to videoconferencing should be examined with respect to their communication needs and the potential of adoption to videoconferencing.

Through interviews and business statistics -- if accessible --, the applications of videoconferencing, the appropriateness of this technology for certain business purposes including type of meeting, message to be conveyed, and value of personal contact, as well as changes in business structure, productivity, and travel behavior should be analyzed.

Furthermore, such an approach should provide a better understanding of secondary incentives that make business travel preferable for individuals. The question may be addressed whether the weight of social, cultural and recreational values of business trips for an individual is impacted by economic forces (particularly cost and time) on one's business activities.

Travel Statistics

By taking travel statistics into consultation, more accurate examinations of changes in travel volume and frequency, in the geographical character of trips, and in purposes for which these trips are conducted can be done. Such an analysis may provide some empirical evidence for or against the hypothesis that productivity gains from videoconferencing use for certain business purposes will free time for other business trips. Statistics and interviews may be able to reveal that travel internal to the company (and often of high frequency) is substituted by trips for inter-company meeting purposes (of less frequency), which were not possible prior to the videoconferencing investment due to time and budget constraints.

Other potential consequences of videoconferencing use that have to be addressed in such an analysis are the intensifying of existing business relations and the freeing of leisure time of individuals through personal productivity enhancements.

Strategic Role of Videoconferencing

By querying people responsible for strategic planning and corporate development, the role of videoconferencing as tool for downsizing management, as well as the significance of videoconferencing for changes in the organizational structure and locational choices of a company can be examined. These trends will have long-term impacts on corporate travel needs and patterns in form of substitution and stimulation, respectively.

Videoconferencing and Travel Policies

Company policies as regards videoconferencing and travel budget and authorization should be part of a field survey -- industry-wide or case-specific. There is still much speculative guessing as to what role such policies have with respect to the net impact of videoconferencing on travel, and whether the company's policies on travel substitution by videoconferencing have a negative impact on employee satisfaction and motivation. The latter effect is suggested by research stressing the role of travel as a status symbol, job privilege, and desirable break from office routine.

Communication Behavior and Perceived Effectiveness of Videoconferencing

The impact of videoconferencing on communication behavior, process and performance, as well as the perceived differences between video meetings and natural face-to-face gatherings, which have been addressed in a few prior studies and in this thesis, need to be confirmed by more rigorous research design. In this context, it is important to examine whether the perceived characteristics of video communications and their differences from natural face-to-face communications are a result of the video medium, or more of the time pressure of working within scheduled time blocks (Svenning, Ruchinskas, and Hart 1993: 77).

A further question is whether users will continue to experience the same video meeting characteristics and behaviors, as costs proceed to decline and videoconferencing becomes a more commonplace resource. Researchers argue whether videoconferencing continues to be more a "business-like" medium when time and availability constraints are lessened. Therefore, research has to proceed to look at the efficiency and effectiveness of videoconferencing in the coming era of widespread video capability and access -- particularly in the era of desktop video (Svenning, Ruchinskas, and Hart 1993: 79).

Empirically Based Analytical Modeling

On the basis of sound empirical research, mathematical modeling techniques for mode-choice behavior between means of modern telecommunications and travel should be developed. Through construction of conceptual frameworks, available knowledge about business activity and travel choices are brought together. Such models can help to define explicit research hypotheses to be tested empirically (Salomon, Schofer 3/1988: 227).

Although most accepted and desirable, today such an analytical approach is rarely employed due to the absence of adequate empirical data on research findings. However, well-founded empirical research may provide the understanding and data of factors underlying mode-choice decisions between enhanced telecommunications and air travel appropriate for model development and calibration.

Types of Business Air Travel

Finally, much more research on the nature of business air travel and its motivations and patterns has to be conducted. There are only a few sources (see section 2.1.2) that try to quantify the share of business air travel, and to identify the composition of overall business air travel by purpose. In addition, existing data sources are characterized by deficiencies in the data collecting method, the comparability of historical data, and the length and completeness of historical data time series. Furthermore, different and partially inconsistent definitions of types of business air travel are applied.

A more disaggregated analysis of air travelers by trip purpose is important for the development of reliable time series allowing sounder forecasting of future demand trends, particularly with respect to the potential impact of modern telecommunications in specific business air travel markets.

For this purpose, a consistent definition of business air travel by purpose is important. Such a description of business trip motivations should not be limited to business functions (engineering, marketing, sales, consulting, etc.), as employed by D.K. Shifflet and Associates (see section 2.1.2), but should also contain the distinction between intra-company and inter-company purposes including customer/supplier contacts and conferences/conventions. With respect to acceptances, preferences, and characteristic adoption patterns of videoconferencing technology, the latter differentiation is essential for a better understanding of

videoconferencing-business air travel interactions. Additionally, a closer look at regional aspects, length of haul of business air travel, and frequency of travel is necessary to allow a better identification of different sensitivities of types of business travel and of air travel markets to enhanced telecommunications, as well as modifications in business travel patterns, such as substitution of certain forms of business trips replaced by videoconferencing through other trips generated by video. A regular survey of business air travelers and corporate travel managers on a wider regional scale using such a disaggregated and coherent description of business trip purposes and characteristics is needed by airlines and aviation organizations, such as IATA, ATA, or AEA.

Today, airlines concentrate on identifying business travelers and isolating those from the pleasure travel segment by recognizing their specific price sensitivities, service needs, and their origins and destinations. From a mere short-term revenue point of view, they have no incentive to analyze business travel demand in a more disaggregated manner. However, a sound knowledge of the breakdown of business air travel by purpose is basic to evaluate potential videoconferencing impacts. After identifying usage patterns, the appropriateness of applying videoconferencing to certain business purposes traditionally requiring air travel (substitutability), and areas where generation and changes of travel patterns as result of videoconferencing might be possible, the knowledge of business air travel characteristics in the disaggregated form suggested above should allow more substantial conclusions as regards videoconferencing-business air travel interactions.

APPENDIX 1: Survey of Videoconferencing Users, Corporate Part

1. About you:

a) Please check the category below that best describes your job function (more than one check is possible):

- Telecommunications Manager
- Telecommunications Analyst
- Videoconferencing Manager
- Other, please specify:

b) How would you evaluate your responsibility in purchasing and other decisions regarding videoconferencing in your company?

- No responsibility
- Function in giving recommendation
- Principal participant in decision making processes
- Final decision maker
- Other, please specify:

c) Is this the first time that you are surveyed regarding the issue of videoconferencing versus travel?

- yes no

d) Would you be interested in obtaining a summary of my study after its completion? If so, please attach your mailing address to your response.

- yes no

2. About your corporation:

a) In what type of industry, you would classify your company:.....

b) In the following, I would appreciate if you could provide me with some information about your company that would help me in the interpretation of subsequently discussed aspects related to the usage of videoconferencing in your company and its impact on traveling.

Number of employees (all sites):.....

Sales of your company in 1993 (if not available, for 1992):.....

3. Present use of videoconferencing:

a) What is the current number, by type, of videoconferencing facilities in your company -- if possible throughout all sites, otherwise please make a note. Please specify that number for the following categories of equipment:

	2-way-video point-to-point	2-way-audio, 1-way video multi-point	2-way audio-video multi-point
Boardroom systems:	_____	_____	_____
Rollabout systems:	_____	_____	_____
Desk-top systems:	_____	_____	_____
LAN-based systems	_____	_____	_____
Other (specify):	_____	_____	_____

b) How many sites (separate offices) of your company are already equipped with any videoconferencing facility? Please specify below (if possible) also the total number of your company's sites worldwide.

..... out of a total of sites.

- c) How long has your company been using videoconferencing for business activities?
 < 1 year 1-2 years 2-3 years 3-4 years 4-5 years > 5 years
- d) What is the size of the group of people in your company that have already used videoconferencing?
 Please estimate that number in absolute terms:
- e) What is the average daily utilization of the videoconferencing facilities in your company? Please specify that below for each category of equipment.
- Boardroom systems:hours/workday
 Rollabout systems:hours/workday
 Desk-top systems:hours/workday
 LAN-based systems:hours/workday
 Other (specify:.....):hours/workday
- f) If available, what were your annual costs for videoconferencing in your company in 1993, including equipment depreciation, transmissions, service/maintenance, and personnel: \$.....

4. Future development of videoconferencing:

- a) With respect to your current plans regarding the future development of videoconferencing in your company, how much, do you think, your videoconferencing budget will grow in the next two to three years (in real terms)?
- no real change 0%-10% 10%-25% 25%-50% 50%-100% > 100%
- b) If you see a potential for further expansion, in what category of equipment the major investment might be most probably done?
- Boardroom Rollabout Desktop-video LAN-based video Other, specify:

5. Applications of videoconferencing:

- a) What are the primary applications of videoconferencing with respect to different departments in your company? Please check the order of importance of the five most frequent user groups (1 = most frequent user). If possible, specify the proportion of each of these groups of the total users of videoconferencing in your company.

Order of importance	Percentage of all applications
..... Administration %
..... Production/Manufacturing %
..... Finance %
..... Sales/Marketing %
..... Engineering %
..... Research/Development %
..... Project Management %
..... Customer Service %
..... Consulting %
..... Communications %
..... Recruiting %
..... Training %
..... Other (specify:.....) %

- b) With respect to the vertical organization of your company, how does the proportion of different management levels of the total videoconferencing-user group look like? Please check the order of importance (1 = most; 4 = least) and, as far as possible, specify the approximated percentage breakdown.

Order of importance	Percentage of all applications
..... Executives/senior management %
..... Middle management %
..... Lower management %
..... Other (specify:.....) %

- c) What proportion of all videoconferences conducted by your company are within the U.S.?.....%

- d) What are the primary applications of videoconferencing in your corporation with respect to different business purposes? Please check the order of importance for the given business activities below (1 = most frequent user). If possible, provide the proportion of each of these groups of the total applications of videoconferencing in your company.

Order of importance	Percentage of all applications
..... Intra-company activities %
..... Inter-company activities %
..... Customer support/service %
..... Conferences/conventions %
..... Training %
..... Interviewing %
..... Other (specify:.....) %

6. Videoconferencing vs. business travel:

- a) Primarily based on the experience you gained during the years of using videoconferencing in your company, how would you rate the potential of videoconferencing to directly substitute for air travel in each of these categories? (1 = "no potential"; 10 = "significantly high potential")

	Circle substitution potential
Intra-company activities	1 2 3 4 5 6 7 8 9 10
Inter-company activities	1 2 3 4 5 6 7 8 9 10
Customer support/service	1 2 3 4 5 6 7 8 9 10
Conferences/conventions	1 2 3 4 5 6 7 8 9 10
Training	1 2 3 4 5 6 7 8 9 10
Interviewing	1 2 3 4 5 6 7 8 9 10
Other (specify:.....)	1 2 3 4 5 6 7 8 9 10

- b) How would you evaluate the importance of savings in travel cost and travel time as part of the justification for investment in videoconferencing equipment in your company?

no importance insignificant importance one of main drivers definitely the most important aspect

- c) If savings in travel expenses and travel time were used in your **initial investment justification**, what substitution coefficient for air travel did you use in that and how did you determine that? Please check the applicable category below and give some brief specifications of your approach.

Percentage substitution for air travel expected at stage of investment:%

Expected annual savings derived from that: \$.....

- Approach used to determine the impact on air travel: Analytical Model/Scenario
 Qualitative assessment
 Field study/survey in company
 Other, please specify:.....

I would be pleased if you could provide me with some additional information about this approach and how you determined the substitution potential and the savings in travel cost and time.

d) With respect to the assessment of the potential impact of videoconferencing on travel you made at the stage of deciding to purchase videoconferencing equipment, how would you evaluate the actual observed effect on the need to travel in your corporation?

- significantly less subst. less substitution as expected more substitution much more substitution

e) To monitor this relationship, do you perform follow-up studies analyzing the impact of videoconferencing on travel?

- yes no

f) How would you today quantify the substitution of videoconferencing for travel in your company? Please check the percentage of videoconferences directly substituting for air travel that applies best to your company.

- 0% 0%-2% 2%-5% 5%-10% 10%-15% 15%-20% 20%-30% 30%-50% >50%

If existing, you can also provide a more precise number for this substitution coefficient:%

The given values base on: qualitative estimates existing study

g) How would you today quantify the annual savings in travel cost and time due to videoconferencing?

..... \$/year

The given value bases on: qualitative estimates existing study

h) To what percentage, air travel is involved in this substitution?%

i) How do you determine this impact on travel (more than one check is possible)?

- Monitoring of business trip expenses of company
Monitoring of number of business trips
Surveying videoconferencing users
Other, please specify:

Please feel free, to give some more information about the way you try to quantify that.

j) Supposing current obstacles regarding your use of videoconferencing (e.g., accessibility, video-, audio-quality, interoperability of systems, ease of use of systems, etc.) can be resolved or further minimized in the future, what percentage of the current business travel in your company might be possible to substitute directly through videoconferencing? Please give a qualitative estimate.

- 0% 0%-2% 2%-5% 5%-10% 10%-15% 15%-20% 20%-30% 30%-50% >50%

k) Several companies also report that a stimulation of business travel can be observed as consequence of productivity gains and a wider scope of business opportunities. How would you rate the potential of stimulation of new travel as a consequence of videoconferencing in your company? (1 = "no potential"; 10 = "significantly high potential")

1 2 3 4 5 6 7 8 9 10

l) How would you rate the chance that this stimulation effect might offset any substitution for travel due to videoconferencing use in your company in a long-term perspective? (1 = "no chance"; 10 = "very high probability")

1 2 3 4 5 6 7 8 9 10

7. Travel budget development and its consequences:

a) If you have information about the development of the overall travel budget of your company in the recent years, what trend has been evident -- in real terms?

- drastic cuts in the budget
- slight cuts in the budget
- no real change
- increase of budget

b) What trend in travel budget is most probable for the future -- again, in real terms?

- drastic cuts in the budget
- slight cuts in the budget
- no real change
- increase of budget

c) If you expect cuts in the travel budget, what response of your business travelers to decreased budgets you evaluate as most probable?

- more videoconferencing
- less meetings (less travel)
- cheaper tickets (change of class)
- other:.....

8. Overall impressions about videoconferencing:

a) What benefits of using videoconferencing would you evaluate as most significant for your businesses? Please assess the following statements (1 = "I strongly disagree"; 10 = "I strongly agree").

Circle level of agreement

- Business trip cost and time savings are significant through using videoconferencing 1 2 3 4 5 6 7 8 9 10
- Videoconferencing enhances significantly the communication flexibility 1 2 3 4 5 6 7 8 9 10
- Videoconferencing allows more structured meetings and larger participation 1 2 3 4 5 6 7 8 9 10
- Spontaneous and accelerated decision making is a significant benefit of videoconfer. .. 1 2 3 4 5 6 7 8 9 10
- Videoconferencing is primarily important to improve customer services 1 2 3 4 5 6 7 8 9 10
- Videoconferencing is an important competitive advantage..... 1 2 3 4 5 6 7 8 9 10
- Videoconferencing generates new business relationships and opportunities 1 2 3 4 5 6 7 8 9 10

b) Using a scale of 1 to 10, please rate in the following the importance of and current satisfaction with different criteria regarding videoconferencing. (1 = "minimum"; 10 = "maximum")

	Importance rating	Satisfaction rating
Conformance to standards	_____	_____
Ease of use.....	_____	_____
Video-performance (frame-per-second-rate).....	_____	_____
Audio-performance	_____	_____
Video-audio-synchronization	_____	_____
Cost.....	_____	_____
Interoperability with other conferencing units.....	_____	_____
Support for external devices and file formats.....	_____	_____

APPENDIX 2: Survey of Videoconferencing Users, Individual User Part

1. About you:

a) Please check the category below that best describes your job function (more than one check is possible):

- Administration
- Production/Manufacturing
- Finance
- Sales/Marketing
- Engineering
- Research/Development
- Project Management
- Customer Service
- Consulting
- Communications
- Recruiting
- Training
- Other (please specify:)

b) Please check the category below that best describes your responsibility within your company:

- Executive/senior management
- Middle management
- Lower management
- Other (please specify:)

c) Is that the first time that you are surveyed regarding the issue of videoconferencing versus travel?

- yes no

2. About your corporation:

a) In what type of industry, you would classify your company:

3. Your use of videoconferencing:

a) Using a scale of 1 to 10, how would you rate your level of familiarity with videoconferencing? Circle one number (1 = "not at all familiar"; 10 = "very familiar").

1 2 3 4 5 6 7 8 9 10

b) How long have you already been using videoconferencing for business activities?

- < 1 year 1-2 years 2-3 years 3-4 years 4-5 years > 5 years

c) When doing videoconferencing, what percentage of time do you use each of the following systems?

	Percentage of use
Boardroom system:	_____ %
Rollabout system:	_____ %
Desk-top system:	_____ %
Other (please specify:):	_____ %

- d) What kind of videoconference do you conduct most frequently?
- 2-way-audio, 2-way-video point-to-point
 - 2-way-audio, 1-way-video multi-point
 - 2-way-audio, 2-way-video multi-point
 - Other, please specify:
- e) How frequently do you use videoconferencing for your business purposes (on average)?
- daily
 - a few times per week
 - once per week
 - a few times per month (up to 4 times)
 - only very sporadically (less than 10 times per year)
- f) Compared to your use of this technology two years ago, how has the frequency of using videoconferencing for your business purposes changed since that time?
- significantly decreased slightly decreased no real change slightly increased significantly increased
- g) What is the average number of persons normally involved in videoconferences you participate in?
- 2 3 4 5 6 - 10 more than 10
- h) What is the average length of videoconferences you participate in?
- < 30 min 30 - 60 min 60 -90 min 90 - 120 min 2 - 3 hrs 3 - 4 hrs > 4 hrs
- i) With respect to the distances over which these conferences are conducted, please check the order of frequency for the given international and domestic distances, as far as applicable to you (1 = "most frequently used for"). If possible, provide the proportion of each of these categories of the total applications of videoconferencing for your business purposes.

Order of frequency	Percentage of all applications
..... Domestic/regional %
..... Long-distance domestic %
..... International to Europe %
..... International to East Asia %
..... International to South/Ctr America %
..... International to Canada %
..... Other (.....) %

- j) What are your primary applications of videoconferencing with respect to different business purposes? Please check the order of frequency for the given business activities below, as far as applicable to you (1 = "most frequently used for"). If possible, provide the proportion of each of these groups of the total applications of videoconferencing in your business.

Order of frequency	Percentage of all applications
..... Intra-company activities %
..... Inter-company activities %
..... Customer support/service %
..... Conferences/conventions %
..... Training %
..... Interviewing %
..... Other (specify:.....) %

4. Your business traveling:

- a) With respect to the distances over which these business trips are done, please check the order of frequency for the given international and domestic distances, as far as applicable to you (1 = "most frequently to travel for"). If possible, provide the proportion of each of these categories of your total business travel.

Order of frequency	Percentage of total business travel
..... Domestic/regional %
..... Long-distance domestic %
..... International to Europe %
..... International to East Asia %
..... International to South/Ctr America %
..... International to Canada %
..... Other (.....) %

- b) What are the primary business purposes you have to travel for? Please check the order of frequency for the given business activities below, as far as applicable to you (1 = "most frequently to travel for"). If possible, provide the proportion of each of these groups of the total number of business trips you have to do.

Order of frequency	Percentage of total business travel
..... Intra-company activities %
..... Inter-company activities %
..... Customer support/service %
..... Conferences/conventions %
..... Training %
..... Interviewing %
..... Other (specify:.....) %

- c) To what percentage, air travel is involved in your total business travel?%

- d) When doing air travel for business purpose, what class do you normally fly?

First-Class Business-Class Economy-Class

- e) How frequently do you air travel for business purposes (in average)?

- daily
- a few times per week
- about once a week
- up to 4 times per month
- only very sporadically (less than 10 times per year)

- f) How has your frequency of business traveling changed in the last two years?

significantly decreased slightly decreased no real change slightly increased significantly increased

- g) Regarding the cost of travel, how would you quantify your average expenses for business trips, including flight, transfers, lodging, meals, etc.?

Average costs per trip: \$.....

How would you estimate your total expenses for business travel per year (in 1993 or in the last 12 months)?

\$..... per year

The given values base on: qualitative estimates existing travel statistics

- h) How would you describe the development of your individual expenses for business travel in the last 12 months compared to the previous period of same length -- in real terms?
 significantly decreased slightly decreased no real change slightly increased significantly increased
- i) What trend in your personal business travel budget is most probable for the future -- in real terms?
 drastic cuts in the budget slight cuts in the budget no real change increase of budget
- j) If you expect cuts in the travel budget, how would your response to such a development most probably look like?
 more videoconferencing less meetings (less travel) cheaper tickets (change of class) other:.....

5. Videoconferencing versus business traveling:

- a) Primarily based on the experience you gained during the years of using videoconferencing in your business activities, how would you rate the potential of videoconferencing to directly substitute for air travel in each of the following categories? (1 = "no potential"; 10 = "significantly high potential"). Only rate the categories that apply to you.

	Circle substitution potential
Intra-company activities	1 2 3 4 5 6 7 8 9 10
Inter-company activities	1 2 3 4 5 6 7 8 9 10
Customer support/service	1 2 3 4 5 6 7 8 9 10
Conferences/conventions	1 2 3 4 5 6 7 8 9 10
Training	1 2 3 4 5 6 7 8 9 10
Interviewing	1 2 3 4 5 6 7 8 9 10
Other (specify:.....)	1 2 3 4 5 6 7 8 9 10

- b) If you see a potential for substituting air travel through videoconferencing, how would you evaluate the percentage of videoconferences you participate in that are already directly substituting for travel?
 0% 0%-2% 2%-5% 5%-10% 10%-15% 15%-20% 20%-30% 30%-50% >50%
- c) Since using videoconferencing, how has the frequency of your traveling changed?
 significantly decreased slightly decreased no real change slightly increased significantly increased
- d) Supposing current obstacles regarding your use of videoconferencing (e.g., accessibility, video-, audio-quality, interoperability of systems, ease of use of systems, etc.) can be resolved or further minimized in the future, what percentage of your current business travel might be possible to substitute directly through videoconferencing? Please give a qualitative estimate.
 0% 0%-2% 2%-5% 5%-10% 10%-15% 15%-20% 20%-30% 30%-50% >50%
- e) Several users of videoconferencing also report that a stimulation of business travel can be observed as consequence of productivity gains and a wider scope of business opportunities. How would you rate the potential of stimulation of new travel as a consequence of videoconferencing regarding your personal business communication needs? (1 = "no potential"; 10 = "significantly high potential")

1 2 3 4 5 6 7 8 9 10
- f) How would you rate the chance that this stimulation effect might offset any substitution for travel due to videoconferencing you might experience today in a long-term perspective? (1 = "no chance"; 10 = "very high probability")

1 2 3 4 5 6 7 8 9 10

6. Overall assessment of videoconferencing:

- a) What benefits of using videoconferencing would you evaluate as most significant for your business? Please assess the following statements (1 = "I strongly disagree"; 10 = "I strongly agree").

Circle level of agreement

Business trip cost and time savings are significant through using videoconferencing	1	2	3	4	5	6	7	8	9	10
Videoconferencing enhances significantly the communication flexibility	1	2	3	4	5	6	7	8	9	10
Videoconferencing allows more structured meetings and larger participation	1	2	3	4	5	6	7	8	9	10
Spontaneous and accelerated decision making is a significant benefit of videoconfer. ...	1	2	3	4	5	6	7	8	9	10
Videoconferencing is primarily important to improve customer services	1	2	3	4	5	6	7	8	9	10
Videoconferencing is an important competitive advantage.....	1	2	3	4	5	6	7	8	9	10
Videoconferencing generates new business relationships and opportunities	1	2	3	4	5	6	7	8	9	10

- b) Using a scale of 1 to 10, please rate in the following the importance of and current satisfaction with different criteria regarding videoconferencing from your point of view. (1 = "minimum"; 10 = "maximum")

	Importance rating	Satisfaction rating
Ease of use.....	_____	_____
Video-performance (frame-per-second-rate).....	_____	_____
Audio-performance	_____	_____
Video-audio-synchronization	_____	_____
Cost.....	_____	_____
Interoperability with other conferencing units.....	_____	_____
Support for external devices and file formats	_____	_____

- c) What problems regarding the use of videoconferencing for your business activities you would evaluate as most critical? Please assess the following statements (1 = "I strongly disagree"; 10 = "I strongly agree").

Circle level of agreement

Cultural acceptance problems of videoconferencing are main barriers.....	1	2	3	4	5	6	7	8	9	10
Time-zone differences are significant obstacles.....	1	2	3	4	5	6	7	8	9	10
Accessibility to videoconferencing systems is still a significant constraint	1	2	3	4	5	6	7	8	9	10
The cost of videoconferencing limits a more extensive use in business	1	2	3	4	5	6	7	8	9	10
The ease of use must be significantly improved to allow more usage	1	2	3	4	5	6	7	8	9	10
The video/audio-performance is still a major deficiency	1	2	3	4	5	6	7	8	9	10
Interoperability with other conferencing units is significantly lacking	1	2	3	4	5	6	7	8	9	10
Support for external devices and file formats is still a notable constraint	1	2	3	4	5	6	7	8	9	10

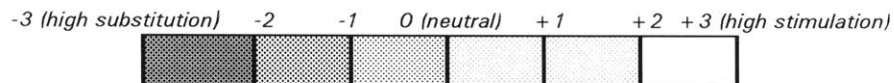
- d) Comparing videoconferencing to actual face-to-face meetings, how would you assess the effectiveness of this technology as regards different activities that take place in direct face-to-face meetings? Using a scale of 1 to 10, please rate the effectiveness of videoconferencing for the given activities from your point of view (1 = "not possible"; 10 = "completely the same as in real meetings").

	Circle effectiveness
Asking questions.....	1 2 3 4 5 6 7 8 9 10
Giving or receiving information	1 2 3 4 5 6 7 8 9 10
Exchanging opinions	1 2 3 4 5 6 7 8 9 10
Giving or receiving orders.....	1 2 3 4 5 6 7 8 9 10
Generating ideas	1 2 3 4 5 6 7 8 9 10
Problem solving.....	1 2 3 4 5 6 7 8 9 10
Decision-making.....	1 2 3 4 5 6 7 8 9 10
Maintaining friendly relations.....	1 2 3 4 5 6 7 8 9 10
Resolving disagreements.....	1 2 3 4 5 6 7 8 9 10
Resolving conflicts	1 2 3 4 5 6 7 8 9 10
Persuasion	1 2 3 4 5 6 7 8 9 10
Bargaining	1 2 3 4 5 6 7 8 9 10
Getting to know someone	1 2 3 4 5 6 7 8 9 10

APPENDIX 3: Survey of Aircraft Manufacturers

Questions related to Videoconferencing vs. Air Travel Demand

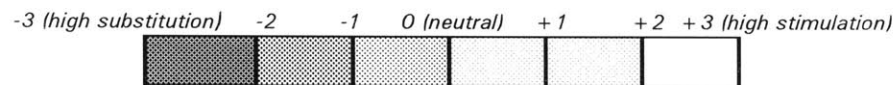
1. How does your company evaluate the overall possible impact of modern videoconferencing technologies on the demand for air travel in the future (next 10 to 15 years, global)? Please rate the level of influence of videoconferencing on air traffic you expect to occur in the future on the following scale from -3 (high substitution) to +3 (high stimulation of traffic).



2. On what basis, the previous evaluation has been given? Please check the appropriate category below.

- Qualitative guess, not based on study, survey, etc.
- Study or survey conducted by your company or in its commission
- Study or survey conducted by others; who?:
- Primarily based on past experience and statistics
- Other (please specify):.....

3. According to your experience and made observation, how would you evaluate the past and current impact of enhanced videoconferencing technologies on the demand for air traffic? Please rate the level of influence on air travel according to the scheme of Question 1.



4. From your experience, to what extent, do you think, the airline industry, as well as the aircraft manufacturers are dealing with the issue "videoconferencing vs. air traffic demand"? Please check the category below that best describes your assessment.

- by no means
- a little
- increasingly
- rather seriously
- very seriously

5. To what extent do you integrate the discussed aspect into your forecasts of future air travel demand? Please rate the level below.

- by no means
- a little
- increasingly
- rather seriously
- very seriously

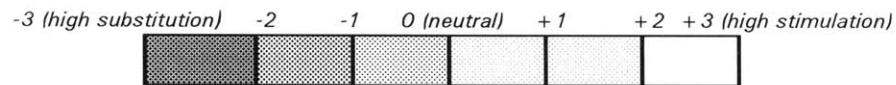
6. If you integrate the possible impact of videoconferencing on air traffic in the future into your traffic forecasts, please specify briefly the approach (model, survey, scenario, etc.) you use below.

7. What level of influence will the current and future development in the videoconferencing area have on the decision concerned with ultra-high-capacity aircraft and supersonic aircraft, both seen as future potential aircraft for important business air traffic markets? Please rate the level below.

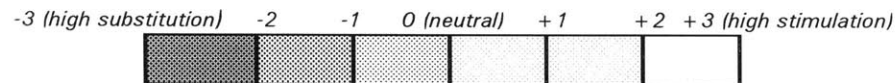
- no influence only insignificantly increasingly high very high

8. Please evaluate on the following scales the expected level of substitution or stimulation of air traffic demand by enhanced business telecommunication technologies in some of the most important business markets. The scale scheme is equivalent to the previously used subdivision.

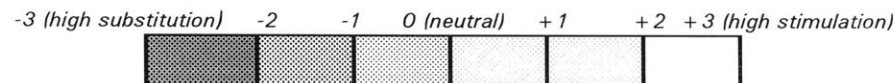
U.S. Domestic:



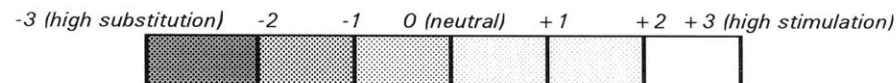
European Common Market:



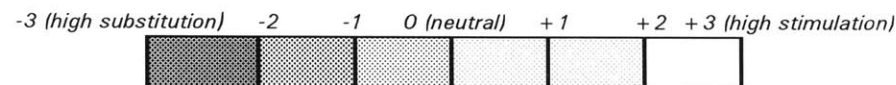
Eastern European Market (Domestic & International):



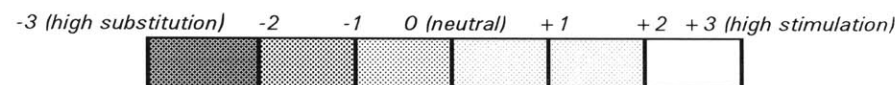
Intra-Asian Market:



North Atlantic Market:



Trans-Pacific Market:



9. Where do you expect the most significant impact (dependent on your evaluation in Question 1, substitution or stimulation) of videoconferencing on air traffic demand in terms of stage length (global market)? Please check the appropriate category.

- short-haul medium-haul long-haul

10. In case of a substitution effect of videoconferencing on the demand for air traffic, what possibilities (if any) do you see for the airline industry to react to such a development? Please specify below your opinion briefly.

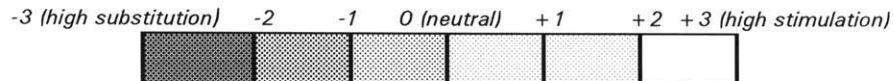
11. What are your current forecasts for the growth of **business air travel** in some of the most important business markets of the world? Please check the expected level of average growth in RPMs per year in the next 10 years below.

U.S. Domestic:	<input type="checkbox"/> 0-1%	<input type="checkbox"/> 1-2%	<input type="checkbox"/> 2-4%	<input type="checkbox"/> 4-6%	<input type="checkbox"/> 6-10%	<input type="checkbox"/> > 10%
Common European:	<input type="checkbox"/> 0-1%	<input type="checkbox"/> 1-2%	<input type="checkbox"/> 2-4%	<input type="checkbox"/> 4-6%	<input type="checkbox"/> 6-10%	<input type="checkbox"/> > 10%
Eastern Europe (D&Intl.):	<input type="checkbox"/> 0-1%	<input type="checkbox"/> 1-2%	<input type="checkbox"/> 2-4%	<input type="checkbox"/> 4-6%	<input type="checkbox"/> 6-10%	<input type="checkbox"/> > 10%
Intra-Asian:	<input type="checkbox"/> 0-1%	<input type="checkbox"/> 1-2%	<input type="checkbox"/> 2-4%	<input type="checkbox"/> 4-6%	<input type="checkbox"/> 6-10%	<input type="checkbox"/> > 10%
North Atlantic:	<input type="checkbox"/> 0-1%	<input type="checkbox"/> 1-2%	<input type="checkbox"/> 2-4%	<input type="checkbox"/> 4-6%	<input type="checkbox"/> 6-10%	<input type="checkbox"/> > 10%
Trans-Pacific:	<input type="checkbox"/> 0-1%	<input type="checkbox"/> 1-2%	<input type="checkbox"/> 2-4%	<input type="checkbox"/> 4-6%	<input type="checkbox"/> 6-10%	<input type="checkbox"/> > 10%
World-wide:	<input type="checkbox"/> 0-1%	<input type="checkbox"/> 1-2%	<input type="checkbox"/> 2-4%	<input type="checkbox"/> 4-6%	<input type="checkbox"/> 6-10%	<input type="checkbox"/> > 10%

APPENDIX 4: Survey of International Airlines

Questions related to Videoconferencing vs. Air Travel Demand

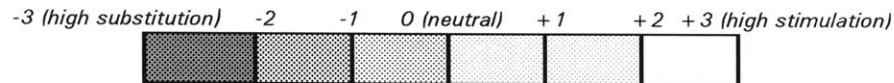
1. How does your airline evaluate the overall possible impact of modern videoconferencing technologies on the demand for air travel in the future (next 10 to 15 years, global)? Please rate the level of influence of videoconferencing on air traffic you expect to occur in the future on the following scale from -3 (high substitution) to +3 (high stimulation of traffic).



2. On what basis, the previous evaluation has been given? Please check the appropriate category below.

- Qualitative guess, not based on study, survey, etc.
- Study or survey conducted by your airline or in its commission
- Study or survey conducted by others; who?:
- Primarily based on past experience and statistics
- Other (please specify):.....

3. According to your experience and made observation, how would you evaluate the past and current impact of enhanced videoconferencing technologies on the demand for air traffic? Please rate the level of influence on air travel according to the scheme of Question 1.



4. From your experience, to what extent, do you think, the airline industry, as well as the aircraft manufacturers are dealing with the issue "videoconferencing vs. air traffic demand"? Please check the category below that best describes your assessment.

- by no means a little increasingly rather seriously very seriously

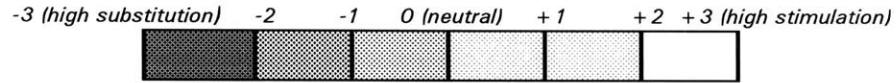
5. To what extent do you integrate the discussed aspect into your corporate, long-term planning? Please rate the level below.

- by no means a little increasingly rather seriously very seriously

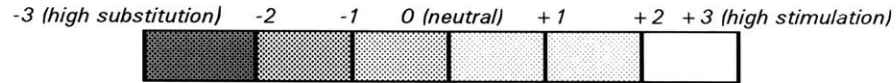
6. If you integrate the possible impact of videoconferencing on air travel demand in the future into your forecasts and planning processes, please specify briefly the approach (model, survey, statistics, etc.) you use below.

7. Please evaluate on the following scales the expected level of substitution or stimulation of air traffic demand by enhanced business telecommunication technologies in some of your most important business markets -- from the listed markets, only choose those appropriate for you. The scale scheme is equivalent to the previously used subdivision.

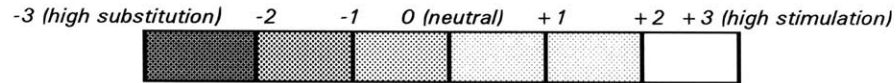
U.S. Domestic:



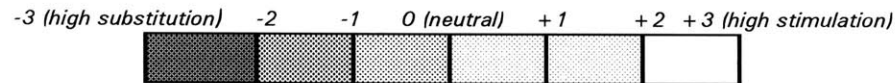
European Common Market:



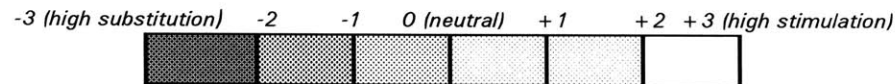
Eastern European Market (Domestic & International):



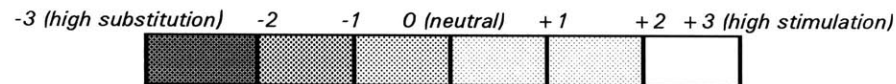
Europe-Asian/Pacific Market:



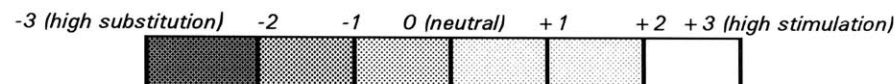
Intra-Asian Market:



North Atlantic Market:



Trans-Pacific Market:



8. Where do you expect the most significant impact (dependent on your evaluation in Question 1, substitution or stimulation) of videoconferencing on air traffic demand in terms of stage length (global market)? Please check the appropriate category.

- short-haul
- medium-haul
- long-haul

9. In case of a substitution effect of videoconferencing on the demand for air traffic, what possibilities (if any) do you see for the airline industry to react to such a development? Please specify below your opinion briefly.

10. What are your current forecasts for the growth of **business air travel** in some of your most important business markets -- again, only assess those appropriate for you? Please check the expected level of average growth in RPMs per year in the next 10 years below.

- U.S. Domestic: 0-1% 1-2% 2-4% 4-6% 6-10% >10%
- Common European: 0-1% 1-2% 2-4% 4-6% 6-10% >10%
- Eastern Europe (D&Intl.): 0-1% 1-2% 2-4% 4-6% 6-10% >10%
- Europe-Asian/Pacific Mkt.: 0-1% 1-2% 2-4% 4-6% 6-10% >10%
- Intra-Asian: 0-1% 1-2% 2-4% 4-6% 6-10% >10%
- North Atlantic: 0-1% 1-2% 2-4% 4-6% 6-10% >10%
- Trans-Pacific: 0-1% 1-2% 2-4% 4-6% 6-10% >10%

11. From your current point of view, what development of **average business fares** (in real terms, adjusted for inflation) do you expect between now and the year 2000 in **your** domestic and international markets? Please check the expected trend below.

- Domestic Markets: significantly decreasing
 decreasing
 rather flat
 increasing
 significantly rising

- International Markets: significantly decreasing
 decreasing
 rather flat
 increasing
 significantly rising

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