Communications Research Centre

RESEARCH REPORT ON TELECONFERENCING

VOLUME 2

by

G.W. JULL, R.W. MCCAUGHERN, N.M. MENDENHALL, J.R. STOREY, A.W. TASSIE,
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CANADA

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PREFACE

Volume 2 summarizes the results and conclusions of studies which were undertaken during a DOC project on teleconferencing. Volume 1 is an executive summary of the information contained in this report. This project commenced in 1972 to meet what was foreseen to be a developing federal government need to provide improved group communications between headquarters and outlying divisions. This report was requested by the Deputy Minister of the Department of Communications to provide a basis for informed discussion with senior officials of DOC, and other federal departments and organizations responsible for decisions on a future course of action for teleconferencing to meet federal government needs.

Section 1 of this report presents background justification for investigating teleconferencing as a telecommunications service to substitute for some business trips. Section 2 reports DOC teleconferencing activities including systems evaluations, technical and behavioural studies, and pre-use attitude studies. Section 3 presents results of an economic analysis of teleconferencing. Section 4 describes teleconferencing developments in countries other than Canada and conclusions from these studies are provided in Section 5. A summary of the teleconferencing situation is presented in Section 6.

As a result of the developing interest on the part of a number of federal departments, including those of the Public Service Commission, Indian Affairs and Northern Development, Environment, Consumer and Corporate Affairs, Regional and Economic Expansion; (and several others), we have proposed tentative characteristics of a system to meet federal needs. This system is described in Appendix A of this report. The costs of the project are included in Appendix B.

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1. INTRODUCTION

1.1 TELECOMMUNICATIONS AS A SUBSTITUTE OR COMPLEMENT TO FACE-TO-FACE MEETINGS

Telecommunications services and travel are closely related to each other and to the structure of our contemporary society. Many consider that the advancement of society depends on increasing both the number and quality of social interactions between its members, and the closely-related growths of telecommunications and travel appear to justify this conclusion. However the increasing costs of travel in terms of economics, energy and time, the consumption of valuable resource materials, and in increasing pollution have been shown to be so high that a strong case can now be considered for fostering travel-substitution by lower-cost telecommunications, whenever this is feasible and desirable. (Ref. 1)

A prime candidate for travel-substitution is the intercity business trip. Existing or new telecommunications systems should make it feasible to meet the needs for many business meetings and thus encourage some substitution by telecommunications. These systems have come to be known as teleconferencing systems, and range from the telephone conferencing service through to computer-based systems, (known as "computer conferencing") and sophisticated closed-circuit television systems.

It appears that many people would be prepared to accept telecommunications as a substitute for travel for some of their meetings. (Ref. 38) A recent Bell Canada survey found that about 20% of some 30,000 bus, rail and air travellers in Canada felt that the business objectives for their trip could have been met using telecommunications. In spite of this, available telecommunications services are seldom used for meetings. Only about 12,000 meetings per year are conducted using the telephone conferencing service

offered by the Trans Canada Telephone System (TCTS) for over twenty years. This contradiction between what people claim they are prepared to accept, and how they actually behave raises a number of important issues. The first is that the service may be considered technically unsatisfactory by most users, therefore technical improvements or new technology would lead to greater acceptance. On the other hand, individuals and organizations could be unaware of what could be accomplished with telecommunications, and therefore publicity and increased familiarity with the potential advantages of telecommunications would result in increased use. Or indeed, it may well be that people prefer to travel to meetings whenever they can because many essential interpersonal communication needs of people cannot be satisfactorally met by telecommunications, either by those services which currently exist or those which could be developed.

When DOC commenced a study of teleconferencing in 1972, no solid base of quantitative information existed to resolve these issues. This may seem surprising considering that we have had over 50 years of experience in using the telephone and twenty years of behavioural research on group communications, which, when combined, should apply to teleconferencing. As a simple example, the accuracy of transmitting information over the telephone compared to face-to-face was not known until quite recently! Now, after extensive investigations by DOC and other organizations such as the Communications Study Group, (CSG) London, the nature of interpersonal telecommunications is more completely understood, and some answers can be given to questions about acceptance and use of new services.

From the outset it can be stated that much of the difficulty in understanding the need for and use of interpersonal telecommunications arises from a widely-held misconception. Many people consider telecommunications as a "substitute" for face-to-face meetings with the implication that it is an inferior substitute. The concept of substitution is valid for economic comparisons, but unsatisfactory when considering all the interactions between telecommunications and travel that now take place, or could take place in the future. Studies described in this report show that it is often accurate to describe telecommunications as a "complement" to face-to-face meetings. We have found that telecommunications can generate unexpected and fruitful new types of interaction. This may occur when certain constraints inherent in face-to-face communications are reduced or, in some cases, eliminated by telecommunications.

The widely-held misconception regarding telecommunications as a substitute for face-to-face meetings may also have been responsible for errors committed by organizations responsible for development and implementation of video telephone facilities. It had been assumed by these organizations in the US and Europe that imagery of participants at a meeting transmitted at video bandwidths, would be so highly desirable that the users would pay the high price of video telephones to have a cost-beneficial service. However teleconferencing using video telephones has not yet been accepted as a suitable substitute for face-to-face business meetings. The visual channel has been found to be more useful to display images of objects or graphics, than to continuously display images of participants at a meeting.

These developments may have diverted effort from the provision of suitable telecommunications systems to meet teleconferencing needs in the

near future. This has left potential user organizations with an unsatisfactory range of options to meet their current needs.

1.2 TYPES OF TELECONFERENCING FACILITIES

It is our contention that teleconferencing should exploit those characteristics of telecommunications which make teleconferencing useful as an important complement to face-to-face meetings, and not only as a substitute for them. That is to say, the use of telecommunications should

(i) permit rapid access to meetings by a large number of potential participants,

(ii) be economical relative to face-to-face meetings,

(iii) permit a wide range of meeting activities to be carried out in a satisfactory manner, and

(iv) permit the evolution of new types of social interaction to improve organizational communications, not otherwise possible with face-to-face meetings.

The question then arises as to which of the systems available today most fully exploit the inherent advantages of telecommunications to provide a useful service. The systems available today include,

(i) the telephone conferencing service (bandwidth of 4 KHz),

(ii) group audio teleconferencing systems (such as the Western Electric 50A set, requiring bandwidths of 4 KHz for audio and additional bandwidth for supplementary facilities),

(iii) computer conferencing systems (such as the Institute for the Future system, known as FORUM, requiring bandwidths of 4 KHz),

(iv) group audio teleconferencing systems augmented with indicator signals (such as the experimental system developed at CRC and the Remote Meeting Table developed in the UK,) and, graphics transmission facilities (requiring bandwidths from 4 to 32 KHz),

(v) video telephones (such as the AT and T picturephone(R), or the French visiophone requiring bandwidths of 1.25 MHz)

(vi) group closed-circuit television systems (such as the Bell Canada Conference TV System and the BPO Confravision System, requiring bandwidths of 8 MHz).

It is important to note that only those systems which can operate over widely-available switched or dedicated networks can exploit the telecommunications advantages of immediacy and convenience. For the near future, this immediately favours narrowbandwidth (4 KHz) or intermediate bandwidth (4 to 32 KHz) systems over video telephone or closed-circuit TV systems (1.25 to 8 MHz). There still remains the question as to whether a wide range of

meeting activities can be held in a behaviourally-satisfactory way with narrow and intermediate bandwidth systems. This has been a principal concern of the DOC studies.

A separate, but related system available today is computer conferencing. This system permits people to interact either on a real-time or on a delayed basis. It can also serve as a limited storage and retrieval system, with the various conferences as a data base. To date most communications have been limited to input from computer terminals, although some experiments with a parallel voice channel are in progress. This is important to fully exploit the potential for interaction offered by this option. This aspect of teleconferencing was not evaluated during the research activities carried out since it had been decided to concentrate on audio and video teleconferencing because of the greater likelihood of wider application.

1.3 INTERNATIONAL INTEREST

Planners in the US, UK and other European countries have initiated a number of programs to examine the feasibility and desirability of substituting telecommunications for travel. Arthur D. Little Inc., has stated that new telecommunications may not only reduce travel but also the volume and cost of mail. Stanford Research Institute has recently undertaken a study for the National Science Foundation on the psychological effects of teleconferencing. NASA has carried out extensive studies on the desirability of substitution considering the current high costs of travel in terms of energy and other resource consumption, pollution, accidents and time. They have also considered some of the less desirable side effects of substitution such as its effect on transportation industries which depend to a large extent on government travel (Ref. 1). The UK government has studied the "communications damage" (reduction of essential communication patterns), which could result from decentralization of selected civil service units from London, and the potential of teleconferencing to reduce this damage (Ref. 2). They have installed, and are using daily, a number of Remote Meeting Tables in decentralized departments. More recently, the members of the Organization for Economic Cooperation and Development (OECD) have questioned member countries on the energy savings possible with increased substitution of telecommunication for travel (Ref. 3). Twelve countries responded and are in agreement on the substantial energy savings involved.

1.4 DOC INTEREST

A good case can be made for lower-cost telecommunications as a substitute for travel within government. The cost of travel and telecommunications in government was approximately $370M in 1973; since 1966 it has been increasing at an annual rate of 33%. (During the same period the annual increase in GNP was 13%). Over this period the percentage of travel costs in the total of travel and communications costs has dropped from 64% to 40%. This may indicate that a considerable fraction of substitution is already taking place; that is, the rapid increase in demand for long-distance business interactions is already being filled more by communications than by travel.

The feasibility and desirability for an increasing rate of substitution may be greater for government departments which are in the process of decentralization than for those which are currently highly decentralized, since departments under the pressure of decentralization may more readily accept the behavioural adaptation necessary to use telecommunications. This remains to be determined. In the meantime, a number of departments have requested DOC to recommend a system to meet their needs. The conclusions included in this report are provided as a basis for informed discussion on a possible course of action to ensure that these needs are met.

Canadian interest in teleconferencing extends beyond the federal government, and many agencies have sought information from DOC on the potential for teleconferencing as a substitute for travel within their organization. Government may have a role to play in this area. It could ensure that pilot projects in travel-substitution, conducted either within or external to government, are carefully evaluated. This would ensure that the social and economic aspects of the desirability of such substitution, and its side-effects on the transportation and other industries, are well understood before policies are considered which could foster an increasing rate of substitution. (Ref. 4).

2. THE DOC TELECONFERENCING ACTIVITIES

2.1 OBJECTIVES OF TELECONFERENCING PROJECT

In November 1971, the newly-created Directorate of Informatique at CRC was instructed to develop research proposals in the area of teleconferencing. Research activities started in March 1972, (Ref. 5), to pursue the following objectives:

(i) to determine the feasibility and utility of various teleconferencing systems, as administrative and management instruments for use by federal departments and agencies,

(ii) to develop a better understanding of the technical and behavioural factors determining the effectiveness of teleconferencing systems,

(iii) to identify the technological limitations of existing systems and to make innovations where possible, and

(iv) to develop some of the necessary skills and competence within DOC to provide recommendations to other branches of DOC concerned with policy and plans for telecommunications development.

2.2 OVERVIEW OF RESEARCH ACTIVITIES

The Socio-Economic Division of the DOC Planning Branch (SEB), now the Social Policy and Programs Branch (SPPB), also commenced a study of teleconferencing in 1972. They developed a program proposal in collaboration with CRC, and defined this program in a report "Teleconference Canada" in August 1972 (Ref. 6). SED undertook to carry out a user needs survey within

government departments, and collaborated with CRC in planning research on teleconferencing by defining objectives of field studies. During the period of SEB (SPPB) responsibilities for studies (June 1972 - March 1974), the activities within the two branches were coordinated by a program coordinator. During this period, SEB (SPPB) made significant contributions to meeting the objectives of the teleconferencing project. From March 1974 until March 1975, CRC was responsible for behavioural/technical research activities on the teleconferencing project. In March 1975 research activity was stopped, pending decisions on a future course of action.

During the period June 1972 to March 1975, CRC undertook three types of activities in order to meet the objectives of the project. The first type was an activity to determine user attitudes to existing teleconferencing systems, known as field studies. The second type was a laboratory activity related to understanding the behaviour of participants in teleconferencing meetings. The third type was a supporting activity covering the following:

(i) user needs surveys (SPPB, CRC),

(ii) studies of teleconferencing room environments (SPPB, CRC),

(iii) technical planning and research studies (CRC) and

(iv) economic studies (Environmental Policy Branch).

Table I summarizes the field, laboratory and non-experimental support activities undertaken during the course of this project.

2.3 FIELD STUDIES OF TELECONFERENCING SYSTEMS

2.3.1 Objectives and Background Information on Systems

Canadian teleconferencing systems have been evaluated

(i) to identify the characteristics of teleconferencing meetings,

(ii) to determine user attitudes and performance when using such systems,

(iii) to determine the desirable technical characteristics of systems,

(iv) to determine the behavioural limitations of their use for various tasks, and

(v) to determine the impact on organizational communications.

These studies are among the most comprehensive that have been carried out to-date. The result of these studies are summarized in Section 2.3.2. The following systems have been evaluated:

Bell Canada Conference TV System (Refs. 7 and 8) - This system was installed in 1972 to provide an intercity video teleconferencing service between central locations in Toronto, Montreal, Ottawa and Quebec City. A

TABLE I

Summary of Field, Laboratory and Non-Experimental Supporting Activities Undertaken During DOC Project on Teleconferencing

1. FIELD STUDIES OF USER ATTITUDES	TIME FRAME
– Bell Canada Conference TV System	1973–74
– University of Quebec Audio Teleconferencing System	1973–75
– DIAND Audio Teleconferencing System	1973–74
– CRC Experimental Teleconferencing System	1973–74
– DOC Regional Audio Teleconferencing System	1974
– TCTS and GTA Telephone Conference Data	1974
2. LABORATORY STUDIES	
– CRC/SPB(PSC) Behavioural Research Lab, Carleton Place	1974–
– Wired City Laboratory, Carleton U.	1973–75
– Studies on Needs for Visual Imagery	1973–75
3. SUPPORTING ACTIVITIES	
– User Needs Survey in Fed. Gov't (SPPB)	1972–73
– DOC Regional Teleconferencing Pre-use Attitudes	1974–75
– Economics of Teleconferencing	1974

similar facility has been installed by the BC Telephone Co. (Ref. 9). To-date, the Bell Canada System has been used for evaluation and market trials. CRC undertook to carry out studies to determine the effectiveness of this audio/video system for a variety of meeting tasks and to compare the user attitudes to this system with the user attitudes to audio systems. The studies were carried out by CSG* who designed a questionnaire and analyzed the data from 206 respondents, in collaboration with DOC and Bell Canada Marketing. The system configuration provides for

(i) up to four TV monitors at each location,

(ii) cameras above and behind monitors, pointing at triads of participants,

* *CSG (Communications Study Group, London), on contract to CRC to carry out the behavioural analysis in the field studies.*

(iii) manual and voice-activated facilities for switching cameras to view speakers, and

(iv) camera facilities for document transmission.

Principal Use - Regular intercity business meetings and demonstrations (Characteristics of meetings and user attitudes are presented in Tables II and III).

Advantages - Video presentation of participants and documents.

- Non voice-switched.

Limitations - Can not be used for meetings with more than two locations.

- Advanced bookings and travel to studio required.

- Not economical for intercity teleconferencing (costs of $600/hour are over ten times the costs of audio-only facilities).

Acceptance - In spite of being available at no charge today, it is seldom used except by Bell Canada employees.

The University of Quebec Audio Teleconferencing System (Refs. 10, 11, 12 and 13) - This system uses dedicated lines, a specially-developed conference switch board and Western Electric 50A teleconferencing sets, to provide an intercity audio teleconferencing service between eight centres of the university in various cities across Quebec. CRC carried out studies to determine the effectiveness of audio teleconferencing for administrative and other types of meetings, with CSG analyzing the data obtained from 153 respondents. The results of this study on audio teleconferencing have been compared with those carried out with Bell Canada on video teleconferencing, in Section 2.3.2 of this report. The principal system characteristics are

(i) portability of sets,

(ii) improved version of voice-switched loudspeaking telephone,

(iii) capability for setting up conference connections for all locations within 15 minutes,

(iv) capability for accommodating between 10 and 100 participants at each location,

(v) facilities for transmitting data and documents, and

(vi) remote writing facilities.

Principal Use - Regular, urgent and other special meetings and some teaching (using tele-writers). (Characteristics of meetings and user attitudes are presented in Tables II and III).

Advantages - Suitable for more than two locations.

- Designed for large groups.

- Rapid interconnection by in-house telephone receptionist using specially-developed switch board.

Limitations - Uncertainty of presence of others (both of speakers and their locations).

- Voice-switched microphones which result in chopped up sentences and irritation to users.

Acceptance - Accepted and used regularly for communications within the university. In spite of technical limitations, the use of this system has grown steadily from 94 meetings in the academic year 1972/73 to 161 meetings in the academic year 1973/74, and has been employed extensively for urgent meetings.

The DIAND Audio Teleconferencing System (Refs. 14, 15 and 16) - The DIAND system uses the CN/CP Telecommunications "Broadband System" to provide an audio teleconferencing service between two locations in Yellowknife, two locations in Whitehorse and one location in Ottawa. In 1973 and 1974, DOC interviewed users to determine their attitudes to the system, and to provide information on the need for extending this service into remote areas of the north. Studies with users of the DIAND system continued until the termination of the project in March 1975. The principal system characteristics are

(i) voice-actuated microphones allowing only one participant to speak from each location at a time,

(ii) capability for accommodating up to 20 participants at one location and a fewer number at the other locations, and

(iii) facsimile for document transmission.

The DOC Regional Audio Teleconferencing System (Refs. 17 and 18) - This system also uses the CN/CP Telecommunications "Broadband System" and has the same principal system characteristics as the DIAND System. It was installed by DOC in October 1974 to provide an audio teleconferencing service between three locations in Ottawa, and one each in Toronto, Montreal, Moncton, Winnipeg and Vancouver. CRC collaborated with GTA in studies to determine pre-use attitudes to the system. It was also planned to investigate the travel-substitution potential and impact on organizational communications which could result from use of this service. This was considered essential to validate the predictions of at least 6% substitution of travel used in the economic study (Section 3 of this report). However, these investigations have been cancelled due to termination of the DOC teleconferencing project.

The uses of the DIAND and DOC systems are summarized below:

Principal Use - Regular and special interregional meetings.

Advantages - Suitable for more than two locations.

- Designed for large groups.

Limitations - Uncertainty of presence of others (both of speakers and their locations).

- Voice-actuated microphones (see under University of Quebec system).

- On occasion, delays of over one half hour in interconnection can occur.

Acceptance - From 1973/75, the DIAND system was used regularly. However, persistent dissatisfaction with the voice-actuated microphones, and network problems resulted in the system being used only occasionally at the time of writing this report. From October-December 1974, the DOC system was used regularly and generated approximately four times the number of face-to-face meetings formerly held between the regions and Ottawa. However, persistent dissatisfaction with the system resulted in the system being used only occasionally, at the time of writing this report.

The CRC Audio-Graphics Teleconferencing System (Refs. 19, 20, 21 and 22) - This system was installed between CRC and DOC/HQ, (separated by 12 miles) and provided an experimental service between these locations from June 1973 until June 1974. This system had open (non voice-switched) microphones, and dedicated 8 KHz audio lines to permit free flowing conversation. The audio was augmented by a number of visual indicators, including a "speaker identification system" and a "wish-to-speak facility". In addition, facsimile and remote writing facilities were provided.

The objective of the studies was to evaluate user attitudes to a system designed to overcome the principal limitations of currently-available systems. Associated with this evaluation was a series of interviews to determine meeting patterns in DOC/HQ and CRC, and attitudes within DOC to teleconferencing.

Principal Use - Regular and other urgent meetings between members of CRC Management Group and other DOC/HQ and CRC groups.

Advantages - Identification of speakers.

- Not voice-switched, and with voice reception of very high quality.

- Provision for graphics transmission and display.

Limitations - Unsuitable for more than two locations.

- High cost for dedicated high quality lines.

Acceptance - Accepted as satisfactory by users, but volume of communications traffic between CRC and DOC/HQ and short distance between these locations resulted in little use of this service after behavioural experiments were complete.

Telephone Conferencing - This service is offered by the Trans Canada Telephone System and by the Government Telecommunications Agency. Handsets or voice-switched loudspeaking telephones are used. Normally not more than eight locations with one to four participants at each location.

Principal Use - Short meetings of about 30 minutes duration related to specialized marketing activities.

Advantages - Uses existing telephone facilities.

- Suitable for more than two locations.

- Most economical system for low volume of traffic.

Limitations - Uncertainty of presence of others, both of who is speaking and where he is speaking from.

- When voice-switched loudspeaking telephones are used, they result in chopped-up sentences and irritation to users.

- Seldom used for typical business meetings with many participants and a wide range of agenda items.

- Advanced booking of 24 hours and, on occasions, delays of up to one half hour in interconnection of more than two locations.

Acceptance - Low level of acceptance, only 12,000 telephone conferences per year in Canada, on TCTS System.

2.3.2 Summary of Results From Field Studies (Refs. 8, 11 and 20)

Extensive field studies were carried out to evaluate and compare user attitudes to the Bell Canada Conference TV system and the University of Quebec audio teleconferencing system. This section summarizes the results of these evaluations and compares them with some data obtained from other systems in Canada and elsewhere.

2.3.2.1 Characteristics of Teleconferencing Meetings

Table II presents characteristics of teleconferencing meetings using various systems in Canada.

Purposes of Meetings - The U of Q audio system was used more extensively than the Bell Canada System for crisis decision-making (15% to 2%) and urgent meetings (51% to 29%). This can be attributed to the greater convenience in

TABLE II

Characteristics of Canadian Teleconference Meetings

	Video (Bell Canada)*	Audio (U of Q)*	Augmented-Audio (CRC)	Telephone conferencing TCTS**	GTA***
Participants Sampled	206	153	30	Indirect data on 12,000 users	60 users
Main Purpose of Meetings (%)					
– information exchange	34	18	100	(see text)	(see text)
– problem solving	23	35			
– crisis decision-making	2	15			
– getting to know someone / – bargaining	2	4			
– others	39	28			
	100	100	100		
Travel time to meetings	⩽20 min	⩽5 min	⩽5 min	⩽5 min	⩽5 min
Average duration of meetings	132 min	110 min	90 min	20 min	32 min
Average number of participants	–	14	8	5	6
Average number of locations	2 (max)	4	2 (max)	–	–
Urgency of Meeting (%)					
– very urgent	6.7	8.9	–	–	–
– urgent	29.1	50.8	–	–	–
– not urgent	64.2	40.2	–	–	–

– *No data*

* *Results from Williams and Holloway (Ref. 8) and Thomas and Williams (Ref. 11)*

** *TCTS – Trans Canada Telephone System (Data provided by A. Brown)*

*** *GTA – Government Telecommunications Agency*

using U of Q system in terms of interconnection time (less than 15 min), travel time to teleconferencing meetings (less than 5 min., compared to about 20 min. for the Bell Canada System) and the number of locations across Quebec which could participate at one meeting.

These two systems were principally used for meetings in which "information exchange" and "problem-solving" were the main purposes. Other studies have also shown that these work-oriented activities are well suited for either audio or video teleconferencing. On the other hand, neither system was used to any appreciable extent (2% and 4%) for "getting to know someone" and "bargaining". These interpersonal socially-oriented activities are known to be poorly suited for teleconferencing.

Telephone Conferencing Compared with Audio and Video Teleconferencing - Meetings using the two group audio systems (U of Q and CRC systems) and the video system (Bell Canada System) were found to be four or five times longer than meetings using the telephone conferencing service. One explanation which may partly account for this is related to the use of telephone conferencing. TCTS has reported that this service is used mainly for specialized information exchange and decision-making meetings related to marketing such as required in the food industry. By way of contrast, the other systems were used for a much more complete range of meeting activities, excluding only those with an interpersonal social-orientation. In addition, there may be more fundamental reasons which are based on some unsatisfactory behavioural aspects of telephone conferencing, related to uncertainty and fatigue, which are believed to be more pronounced than with group audio conferencing systems. These remain to be investigated. However, it is increasingly evident that the small amount of use made of the telephone conferencing service today (only 12,000 calls per year), is due to the facilities being unsuited to most meeting activities.

The University of Quebec claim that three most important elements in the success of their system are (i) the conference bridging facility is located in the University and operated by their switchboard operator, (ii) a quality conference set is used and (iii) dedicated lines are used where possible (Ref. 12). They developed their system after finding the telephone conferencing service to be unsuitable.

2.3.2.2 Users Attitudes and Acceptance

Table III presents some of the factors which influence user attitudes to audio and video teleconferencing. A higher percentage of audio system users than video system users felt that there was a tendency for the system they were using to produce polarization between the groups, and to lead to some uncertainty of the presence of others. In other respects the responses of audio and video users were generally similar. It was not felt that teleconferencing slowed down decisions, it was found to be convenient, but unsuitable for confidential discussions. The atmosphere of meetings was found to be less friendly and more business-like than face-to-face meetings, with audio meetings being more extreme than video in these respects. These findings support those obtained in the study of the CRC system. (Ref. 20).

The attitudes of UK and Canadian users of teleconferencing systems have been found to be surprisingly similar. As an extension of the DOC study on user attitudes, CSG has compared the "satisfaction with the system" for users of the BPO Conference TV System (Confravision) and the UK Civil Service augmented-audio system (the Remote Meeting Table) with the "satisfaction with the system" for users of the Bell Canada Conference TV system and the University of Quebec audio system. For work-oriented activities, all four user groups found teleconferencing satisfactory compared to face-to-face meetings with little difference between audio and video groups. For interpersonal, socially-oriented activities all groups found teleconferencing much less satisfactory, with audio groups being more extreme in their judgement. (Ref. 11).

2.3.2.3 Teleconferencing Used to Complement Face-to-Face Meetings

One of the most important findings of the University of Quebec study has been the extensive use of their audio teleconferencing system to comple-

TABLE III

*User Attitudes to Teleconferencing**

	Audio (U of Q)			Video (Bell Canada)		
	Agree%	Neither %	Disagree %	Agree %	Neither %	Disagree%
1. STATEMENTS ABOUT TELECONFERENCING						
– EASE OF FEEDBACK AND PERSONAL CONTACT						
non-certainty of presence of others	52	12	36	20	10	70
tendency to polarize groups	52	9	39	32	22	46
no impression of personal contact	41	17	42	28	15	57
decisions slowed down relative to face-to-face	14	16	70	32	22	57
it provides a great sense of realism	32	33	35	47	29	24
people pay less attention than face-to-face	16	15	69	12	17	71
it is straight forward and easy to use	92	4	4	92	4	4
– PRIVACY – (suitable for confidential matters)	6	14	80	31	23	46
– CONVENIENCE						
convenient for busy people	84	4	12	78	15	7
meetings shorter	72	8	20	45	32	23
2. ATMOSPHERE OF MEETINGS	MORE %	THE SAME %	LESS %	MORE %	THE SAME %	LESS %
face-to-face meetings are						
heated	35	58	8	30	65	5
friendly	50	42	8	33	59	8
business-like	21	52	27	11	73	26

* *Results from Williams and Holloway (Ref. 7) and Thomas and Williams (Ref. 9)*

ment face-to-face meetings and generate new patterns of communications between widely-separated individuals in their organization. In addition to being used for regular meetings, the system has been used for

(i) executive elections,

(ii) preparing for face-to-face meetings,

(iii) forming an attitude before negotiation,

(iv) stimulating participation and

(v) dealing with emergencies.

Approximately one half of 255 meetings held over their system in a two-year period are classified as "unscheduled impromptu" meetings, carried out as part of the process of their on-going work. (Ref. 11). This may be analogous to telephone usage or unscheduled face-to-face meetings in other centralized organizations. In summary, the use of the system helps to provide a high level of overall contact between individuals within this decentralized organization.

Evidence on the meeting-generation effects of teleconferencing was also obtained during the three-month period in which the DOC Regional System was operational. Face-to-face meetings in Ottawa with regional directors, previously held once every two months, were "substituted" or complemented by meetings held once every two weeks.

2.4 LABORATORY STUDIES ON COMMUNICATIONS BEHAVIOUR

2.4.1 CRC/SDB Behavioural Research Laboratory, Carleton Place

Laboratory activities were planned to identify and determine the importance of variables related to the behaviour of individuals and groups, which could affect the acceptance and usefulness of teleconferencing and other types of interpersonal telecommunications. Negotiations with the Staff Development Branch/PSC (SDB/PSC) in 1973 led to an agreement between SDB and CRC to collaborate in behavioural research, at the SDB Management Training School in Carleton Place, Ontario. An Experimenter's Committee, with representatives from SDB, CRC and SPPB was formed to define the research activities required by each organization, and make mutually satisfactory arrangements to carry them out. This laboratory provides an environment ideally suited for some aspects of interpersonal telecommunications research of concern to the federal government. This is because

(i) tasks carried out in this research relate closely to many tasks which are carried out in the government, and

(ii) the research managers, course directors and federal government management personnel on courses can assist in defining as well as answering the important behavioural questions.

In mid 1974, CRC installed the telecommunications systems required in the behavioural laboratory. These consist of a variety of audio and video terminals and interconnection facilities for up to four nodes. After an initial evaluation period, the first experiment with management personnel as research participants commenced in September 1974. During 1974/75 approximately 400 management personnel from across Canada took part in the evaluation of new types of telecommunications with application to communications within their departments. A number of experiments have been completed (Refs. 23 and 24).

The terms of the agreement permit SDB to carry out research using the telecommunications systems in the laboratory. They are planning a series of experiments related to their requirements for management and language training by remote means.

The Carleton Place Laboratory is the principal research facility for the CRC behavioural scientists and can be expected to be of continuing value for many necessary studies of person-to-person communications. The only comparable facility is the laboratory installed in the UK Civil Service College, Sunningdale, Berkshire which is being used for studies with UK civil servants as research participants.

2.4.2 Wired City Laboratory, Carleton University

The facilities of the Carleton University Wired City Laboratory have been used by university researchers on contract to DOC to carry out important supporting experiments on the effectiveness of audio and video conferencing compared to face-to-face meetings. University students have been used as research participants in these studies (Refs. 25 and 26). Results of these studies have been used to identify behavioural limitations of audio teleconferencing, which require further investigation for particular types of audio teleconferencing applications.

2.4.3 Summary of Laboratory Results and Comparison with Field Results

Certain results of laboratory studies on attitudes and performance of users of teleconferencing systems have supported related results of the field studies. For example, the laboratory studies at the Behavioural Research Laboratory, Carleton Place (Ref. 23 and 24) and at the Wired City Laboratory (Ref. 26) showed that audio systems tended to polarize the groups and created uncertainties to a greater extent than face-to-face meetings. In addition, it was found that participants spoke less at audio meetings than at video or face-to-face meetings (Ref. 27). These results support the results of the field studies. (In addition to polarization effects and uncertainty, it was found that participants in audio meetings in the field spoke less often than at comparable face-to-face meetings). On the other hand, other laboratory results were surprisingly different from the field results. First, the laboratory studies found no significant differences in aggression, anxiety, fatigue and concentration that could be attributed to the media. (Ref. 33). These findings are in disagreement with those from field studies, which found that teleconferencing meetings required a greater degree of concentration and were more tiring than comparable face-to-face meetings. Secondly, laboratory studies that found that audio meetings led to less complete recommendations than video or face-to-face meetings cannot be readily

reconciled with the acceptance of audio systems for problem-solving tasks by various organizations.

Some of these disagreements may be explained by differences in laboratory and field studies. The average length of teleconferencing meetings in the laboratory was only one half hour, while the length of meetings in the field averaged about 1.5 hours, with the result that fatigue would be expected to be more pronounced in the field use. There were also differences in several behavioural factors which may have been important. Firstly, in the field, users participated in meetings as part of their on-going work, which was not the case in the laboratory. Secondly, in the field, many users had considerable experience and were acquainted with other users, which was not necessarily the case in the laboratory. The importance of experience with teleconferencing in determining attitudes and performance, and the effects of attitudes and acquaintanceship in predicting the use of teleconferencing remain issues of major importance in teleconferencing studies.

The effects of experience have now been partially determined in the field studies. First-time users of the University of Quebec system felt that face-to-face meetings would have been more successful. With experience, participants felt that realism improved the meetings, the meetings were more business-like and cordial and they perceived the medium as being more useful for generating ideas. Experienced users also held larger meetings, with more locations participating than inexperienced users (Ref. 11). Effects of experience were also found with the CRC system users. It was found that between the first and fifth meetings (over a three month period) the attitudes towards teleconferencing improved for bargaining, persuasion, and getting to know someone (Ref. 20).

These observations of the effects of experience on attitudes for audio users are quite different than the effects of experience for video users. It was found that first-time users of the Bell Canada video system liked it better than more experienced users (Ref. 11). Perhaps this indicates a short-term novelty effect, associated with the use of video for interpersonal communications rather than entertainment!

Other laboratory studies have compared various audio terminal facilities, used in two-node situations. The systems compared were an open microphone system, a voice-switched microphone system (the Northern Electric Companion set), a light weight microphone-ear piece set (The Northern Electric Venture 1 headset) and Stennheiser headphones. Preliminary, and as yet unpublished, results have shown a marked preference for the open microphone and Companion set over the others. On the other hand, UK research has found that headphones are preferred over UK voice-switched facilities (Ref. 28). Therefore the optimum substitute for an open microphone is not yet known.

2.4.4 Needs for Visual Information and Feedback

Studies were commenced to define the relationships between auditory/visual information bandwidths, the need for feedback of visual information in teleconferencing, and the implications for carrying out various tasks. Our studies have shown that the socio-emotional content of interpersonal communications, as contrasted to the cognitive or work-oriented content, is reduced by elimination of the visual channel. This has quite different

implications for various meeting activities. For example, unpublished laboratory studies of persuasion tasks have shown that the imagery of a person transmitting information is more important, both to the *receiver* of information and to the *transmitter*, than the imagery of the receiver. On the other hand, for other tasks the reverse applies. (Ref. 29). These results have implications on the utility of assymetric telecommunications channels, with the possibilities of sharing video bandwidth for two-way transmissions. An information-theoretic model to predict the utility of symmetric and assymetric channels for auditory and visual information in interpersonal communications was developed, and remains to be tested in the laboratory (Ref. 30).

In addition, preliminary behavioural/technical interface studies commenced to examine the potential of slow-scan TV tranmsission of imagery of participants and documents, to support audio-only teleconferencing. The RCA "Video-Voice" system was found to lack the grey-scale levels and required resolution for these purposes. To overcome the limitations of such systems, an interactive slow-scan TV system was developed with capability for transmission of documents and imagery of participants. It is now being assessed for a different image communications application. (Ref. 31).

2.5 SUPPORTING ACTIVITIES

2.5.1 User Needs Survey in Federal Government (SPPB) (Ref. 32)

During 1972, SEB (SPPB) undertook a user needs study, to sample the attitudes of federal government managers towards teleconferencing. Managers from DOC, M and I, MOT, DPW, DIAND, DOE, NH and W, and PSC were respondents in this study. Although most respondents were unsure of the application of teleconferencing to their work, 65% agreed that teleconferencing would permit better co-ordination with the regions, and 70% believed it would save overall costs. Respondents from M and I and PSC had the most positive attitudes towards teleconferencing (and ironically, DOC respondents were least interested). Senior managers perceived greater utility for teleconferencing, and had more favourable attitudes to it, than did middle managers or technical groups who were sampled.

In summary, while relatively few were very strongly in favour of teleconferencing, almost nobody opposed it. Most people were relatively ambivalent towards its use.

2.5.2 DOC Regional Teleconferencing Pre-use Attitudes (Ref. 17)

In the summer of 1974, a questionnaire survey was conducted in the regional offices of the Department of Communications to determine the attitudes and perception of managers towards the installation and usage of the DOC audio teleconferencing system prior to introduction. Some results of this survey are presented in Table IV and summarized below:

(i) regional respondents indicated more positive attitudes towards the introduction of teleconferencing than headquarters respondents, and

TABLE IV

Pre-Use Attitudes to Teleconferencing (DOC/HQ and Regions)

	HEADQUARTERS			REGIONS		
Attitude Statement	**% Agree**	**% Not Sure**	**% Don't Agree**	**% Agree**	**% Not Sure**	**% Don't Agree**
Permit better co-ordination with regions	39.0	57.6	3.4	69.6	28.3	2.2
Would make communications too impersonal	40.7	42.4	16.9	14.9	23.4	61.7
Managers would use it	40.7	55.9	3.4	66.0	27.7	6.4
Needed to permit better coordination in Ottawa	22.0	61.0	16.9	26.8	70.7	2.3
People in my department would be receptive	37.3	59.3	3.4	63.0	30.4	6.5
Too many meetings; teleconferencing would make it worse	52.5	33.9	13.6	2.2	15.2	82.6
Save travel time	67.8	20.3	11.9	83.0	8.5	8.5
Save overall costs	32.2	49.2	18.6	34.0	57.4	8.5
Would be unpopular; people like to travel	40.7	45.8	13.6	14.9	42.6	42.6
Use limited; contacts mostly external	28.8	33.9	37.3	16.7	22.9	60.4

(ii) the perceived need and utility of teleconferencing facilities were higher in the regions than those reported by headquarters respondents.

3. ECONOMICS OF TELECONFERENCING

3.1 COST SAVINGS - US EXPERIENCE

During the Apollo moon landing program, NASA installed an eleven terminal audio-graphics teleconferencing network, to facilitate technical and policy exchanges between the widely-scattered manufacturing test and management centres in the program. The total costs of this system were about $500,000 a year. According to NASA's analysis the travel budget in one year was reduced from $2.5M to 1.2M. They estimate that each dollar spent on teleconferencing saved three to five dollars in travel.

3.2 ECONOMIC ANALYSIS OF TELECONFERENCING FOR FEDERAL GOVERNMENT USE

3.2.1 Savings with Teleconferencing - Method of Analysis

An analysis has been carried out to determine the economic feasibility of a teleconferencing system for use within the federal government. The use of teleconferencing to substitute for some business trips results in savings in expenditures for travel, accommodation, meals, executive and staff time, and other pre-meeting incidentals such as telephone calls, taxis, car rentals, parking fees, etc.

Teleconferencing is an "investment" requiring answers to two basic questions:

(i) Is there a demand?

(ii) Will the investment be profitable?

To answer the first question, DOC conducted a review of its own travel and accommodation costs for FY 1972/73. Recognizing that DOC travel represented only a small portion of overall government travel, it was decided, nevertheless, to extrapolate the DOC data to get a first assessment of the overall impact. Conservative assumptions were made as to which trips might have been substituted for by teleconferencing, based on information on uses of teleconferencing determined in the field studies of Canadian systems. The direct and hidden costs of planning and carrying out the selected travel applications were then estimated.

The profitability of an investment in teleconferencing was then determined. This was done by using estimated cost figures to develop a cash flow model which was applied to determine the rate of return on the investment.

3.2.2 Demand for Teleconferencing

The analysis of field studies has shown that teleconferencing cannot substitute for many types of travel that take place. To provide a conservative basis for estimating demand, only a small percentage of trips were accepted as eligible for substitution. Unfortunately, the reasons given for travel in individual applications were often vaguely - worded. It was clear that such activities as removal, annual leave, duty away from home, or transmission of highly classified documents could not be considered. Business trips of one day duration in Canada were selected, with multi-destination trips considered to be a collection of one day trips.

As a result of these reasonable constraints, meetings qualifying for substitution included regional meetings, seminars, other federal government business meetings, and headquarters meetings. All other types of government business meetings were excluded. These were classified as *Personnel Matters* (training, recruiting, board hearings, promotions or duty away from home) (since most personnel activities cannot be substituted effectively by teleconferencing systems today). *Contract and Legal* (discussions or lectures with industry, provinces, regional governments and universities), *Technical* (management of private companies, aerospace and telecommunications projects, inspections and testing). *Contract*, *Legal*, and *Technical* meetings were external to government and no facilities may be available for these meetings; and *VIP* (ministerial travel, medical escort and other special trips).

3.3 COSTS OF A TELECONFERENCING SYSTEM

To assess the profitability of a national teleconferencing system, costs were developed based on the costs of implementing a system with tentative characteristics. The total development and implementation costs of $17,850,000 and annual operating costs of $1,785,000 are arrived at as follows:

a) Capital Costs:

(i) Terminal Equipment - For a typical national teleconferencing system, 3000 terminals are assumed sufficient to meet the needs of government. The distribution of costs is as follows:

1500 desk terminals (on average, one terminal for each executive-level person) at $1100 = $1,650,000

1500 room terminals (on average, one terminal for each 200 personnel) at $4000 = $6,000,000.

(ii) Transmission Facilities - Transmission facilities are estimated to cost $2,400 for each terminal, giving a total cost for these facilities of 3000 x $2400 = $7,200,000.

(iii) Room Conditioning Costs - The teleconferencing system would require some $2000 per conference room terminal for acoustics conditioning and additional facilities required to equip rooms for teleconferencing meetings. The total cost of this

conditioning is 1500 rooms x $2000 = $3,000,000. The total cost of the teleconferencing system is then $17,850,000.

b) Operating Expenditures

Operating expenditures are assumed to be a fixed proportion of capital costs. Based on figures of other offerings*, an upper bound of 10% is estimated to be sufficient for operating the teleconferencing system. This expenditure will be $1,785,000.

3.4 RESULTS OF ECONOMIC ANALYSIS

3.4.1 Analysis of a System for the Department of Communications

The analysis of the Department of Communications travel expenditures for 1972/73 provide the following data:

a) Demand for Teleconferencing

Domestic travel amounted to $513,866 (42%) while foreign travel accounted for $707,777 (58%). Of a total of 3097 domestic trips costing $513,866 only 170 or 5.5% were selected as appropriate for teleconferencing substitution. Direct and indirect costs of an average Department of Communications trip were calculated to be $236, considering all expenditures associated with travel including the average value of time of DOC employees. Assuming a 20% growth rate, travel costs per trip would reach the level of $314, and the number of trips would increase to 226 in 1975/76.

b) Financial Results

Based on a capital expenditure of $212,000** to implement a Department of Communications teleconferencing system comprising 10 desk and 10 room terminals, a rate of return of approximately 20% is expected if 226 trips can be substituted for by teleconferencing by 1975-76. This represents only 5.5% of the expected number of trips, and would cost about 3.2% of the total domestic budget for travel. An increase in this number to 286 trips, or 6.9% of the total, would result in a rate of return of 30%, over an eight year period***.

3.4.2 Analysis of a System for the Federal Government

Using the findings for the Department of Communications and extrapolating them to the federal government, the following results were obtained:

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* *Bell Canada/Telesat service offerings in Trout Lake, Ontario*

** *Capital costs includes the provision of 10 desk terminals at $2000 each, 20 room terminals at $10,000 each, transmission facilities at $3600 per terminal, and room facilities for the 10 rooms at $2000 each.*

*** *It is assumed that the economic life of the teleconferencing equipment is eight years.*

a) Demand for Teleconferencing

- For FY 1972/73 the federal government expenditure for domestic and foreign travel was $150,234,121.

- Assuming conservatively that domestic travel costs amounted to 42% of the total, domestic travel would cost $63,098,330.

- If 3.2% of domestic travel costs is substituted for by teleconferencing, then the federal government demand equals $2,019,147. Adding indirect costs to direct costs a total of $4,805,570 is obtained. The cost per trip being $236, then a total of 20,363 federal government trips could be substituted for by teleconferencing.

- Assuming a 10% annual growth rate, travel costs per trip would reach the level of $314 in 1975-76 and the number of trips would increase to 27,183.

b) Financial Results

Based on capital expenditures of $17,850,000 for a federal teleconferencing system comprising:

- 1500 desk terminals at $1100 each

- 1500 room terminals at $4000 each

- transmission facilities at $2400 per terminal

- room conditioning, 1500 rooms at $2000 each a return of 36% over an eight year period is expected if 27,103 trips are substituted for by teleconferencing in 1975-76. These 27,103 trips represents only 5.5% of the expected number of trips and would cost about 3.2% of the domestic budget for travel.

3.5 CONCLUSIONS

A re-allocation of 3.2% of total federal domestic travel budget to teleconferencing would yield a return of 36% over an eight year period. The difference between the rates of return for the Department of Communications and the federal government (20% versus 36%) reflect economies of scale that can be achieved.

By way of comparison, video teleconferencing is not cost-beneficial to-day, Terminal and transmission costs for video systems are approximately ten to twenty times higher than the costs for audio facilities.

4. TELECONFERENCING DEVELOPMENTS IN OTHER COUNTRIES

4.1 SYSTEMS AVAILABLE ELSEWHERE

In the past decade, many telecommunications organizations abroad have supported research to produce video telephones or TV conferencing systems. In addition to the Bell (US) "picturephone", there is now a GPO (British) "viewphone", a CNET (French) "visiophone", and similar TV phones developed by Philips (Holland) and Ericksson (Sweden). In addition, the GPO, AT&T and the Australian Post Office (APO) have developed conference TV systems similar to that of the Bell Canada. Various audio systems have been developed in the UK and the US, and computer conferencing systems have been developed in the US. (Recently advanced computer conferencing systems have been implemented in Canada, in NHW and in Bell Canada). Information on the uses and characteristics of these teleconferencing systems have been made available to DOC by the respective organizations:

1. *Audio Teleconferencing* - ("Remote Meeting Table" - improved audio system being implemented for use in UK Civil Service Departments. Two locations with up to twelve participants per location for a meeting).

Principal Use - Regular and special meetings.

Advantages - Identification of speakers.

- Not voice-switched.

Limitations - Unsuitable for more than two locations.

Acceptance - The first system (UK Scottish Office) has been accepted and is regularly used.

2. *Audio Teleconferencing* - ("Darome Convenor" - improved audio system designed to replace the Western Electric 50A set, implemented and used in the Education Telephone Network of the University of Wisconsin - Extension. Centres in over one hundred communities with a total of 173 locations are connected to a dedicated 4 wire system. Slide projector with remote control capabilities are included). (Ref. 34).

Principal Use - Teaching extension courses.

Advantages - Suitable for more than two locations.

- Designed for groups of up to 200 people at each location.

- Rapid interconnection with specially-developed conference bridging systems.

- Uses dedicated 4-wire system.

- Feedback and sharing resources in education.

Limitations - Uncertainty of presence of others which makes it difficult to make geographically-dispersed people feel like a "group".

- Voice-switched microphones (see under telephone conferencing).

Acceptance - Used extensively by the University of Wisconsin, Extension. More than 25,000 are enrolled in extension courses, and use the facilities located in the centres.

3. Video Telephones - (US, UK, France, Sweden, Holland and Japan)

Principal Use - Specialized meetings - medicine (US) and engineering (Holland and Sweden).

Advantages - Ability to display various types of images.

Limitations - Not economical for intercity teleconferencing (High cost for video which adds little to business meetings).

Acceptance - Accepted for special intracity communications activities.

4. Computer Conferencing - (US, and more recently, Canada (NH and W, DREE))

Principal Use - Interactions between experts in various professions and a mailbox service, using computer terminals.

Advantages - Interaction either in real-time or on a delayed basis, overcoming time as well as geographic limitations.

- Uses telephone network.

Limitations - Currently limited to typing in opinions and information with a teletype keyboard.

- Learning requirements.

Acceptance - Accepted for exchanging opinions and information on a wide range of subjects.

4.2 CRITIQUE OF AUDIO AND VIDEO SYSTEMS AVAILABLE ELSEWHERE

Audio Teleconferencing - In the UK, the Communications Studies Group has developed an audio teleconferencing terminal known as the "Remote Meeting Table" which is now being installed in several departments of the UK government. Although the "Remote Meeting Table" is well accepted for two-location meetings, in its current form it does not meet the Canadian need for terminals capable of being interconnected for multi-location meetings.

In the US, the government has recently installed an eleven-location system using the Western Electric 50A Set. The University of Wisconsin-Extension has accepted the "Darome Convenor" as a suitable terminal for

teaching applications. (There is currently no assessment of the comparative effectiveness of the Darome Convenor relative to other audio systems available in Canada). NASA audio-graphics system (referred to in Section 3), is especially useful for problem-solving activities requiring 50 kilobit/sec lines to handle required graphics transmission.

Video Telephones - In the video telephone field, almost all telecommunications organizations have followed in the footsteps of AT&T. It has cost AT&T $250M in picturephone development and trials to find that intracity video systems are not worth the cost for most interpersonal communications tasks. Only 500 subscribers retain their systems at present. Video systems are needed and used only when imagery is essential for the tasks. In general, these tasks are specialized, and of the type carried out by professionals and other workers.

Managers do not carry out specialized tasks at business meetings. For example, in Holland and Sweden (Ref. 35) the TV telephones were originally placed on the desks of managers. There they gathered dust and were occasionally used. Finally they were taken out, and placed in production and design departments of the companies (Phillips and Ericksson). There they have remained, and are being put to good use for specialized tasks (such as discussions on engineering design).

5. CONCLUSIONS FROM STUDIES

The results of the DOC studies together with the results of UK and US studies form the basis for the conclusions provided in this section of the report. These will be considered in the following categories:

(i) those related to the technical planning and implementation of teleconferencing systems,

(ii) those related to the organizational advantages and disadvantages of teleconferencing, and

(iii) those related to the behavioural advantages and disadvantages of teleconferencing.

5.1 TECHNICAL PLANNING AND IMPLEMENTATION OF TELECONFERENCING SYSTEMS

5.1.1 Choice of Media for Intercity Teleconferencing

CSG meeting survey studies show that audio teleconferencing systems could substitute for up to 40% of present day meetings without loss of meeting effectiveness. (Ref. 36). Video teleconferencing could be used to substitute for an additional 20% of typical meetings but is estimated to cost over 10 times as much today*. (Whilst audio teleconferencing *could* substitute for 40% of meetings, there are other factors, such as the ease of travel, negative attitudes to teleconferencing, and slight degree of acquaintenceship of participants, which will result in a much smaller fraction of meetings being held by teleconferencing).

* - See top of Page 27.

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* *The perspective adopted in this document is that of an organization concerned with meeting short-term needs of its users. This may not be the same as that adopted by the common-carriers (who may be concerned with the long-term market impact of such services as the TV Conference System).*

5.1.2 The Need for Intracity Teleconferencing

At present, only very few intracity teleconferencing systems are extensively used. (These are principally video systems for specialized purposes such as telemedicine (US) and others used for discussions between workers in manufacturing industries (Holland and Sweden)).

In general, if travel times are less than the order of an hour, it can be concluded that teleconferencing will not be used to substitute for a significant fraction of trips. (This is the UK experience, and the DOC experience with the CRC system). It is therefore concluded that intracity teleconferencing is not an important present need except when it is associated with intercity teleconferencing, or for specialized applications.

5.1.3 Access to Terminals

Room Terminals: Results of studies indicate that an important factor governing the use of a teleconferencing system is related to the ratio of the distance to travel to the face-to-face meeting, to the distance to travel to a terminal. This factor may partially account for the low utilization of large centrally-located TV conferencing facilities in the UK and Canada. (For example the Bell Canada Video System Study shows that over 50% of the users travelled less than 20 minutes to get to the facility and only 10% travelled more than an hour, in spite of the fact that the service was offered on a no-charge basis and teleconferencing saved a trip of between 200 and 400 miles. On the other hand, the University of Quebec System, with one terminal on each floor of the headquarters building, is well-utilized). Therefore, at least one room terminal should be provided in each building occupied by users.

Desk Terminals: Based on the arguments presented above, a system based on desk teleconferencing terminals, (being the most accessible), should be well used. On the other hand, conferencing by telephones has never been accepted. It is believed that this is due to a number of behavioural limitations, some of which could be overcome if indicator facilities were provided to identify conference participants and who is speaking. Therefore, desk terminals should be designed to permit a small group to use the terminals in offices. In addition, further behavioural research would have to be carried out to determine the advantages and disadvantages of teleconferencing using desk terminals (with individuals or small groups at many terminals), compared with teleconferencing using room terminals (with larger groups at a few terminals). Results of this research would allow an organization to decide on the relative importance of desk and room terminals to meet its needs for an effective service.

5.1.4 Indicator Signals for Audio Teleconferencing

Studies at CRC and in the UK have confirmed the usefulness of indicator signals to augment voice signals in audio teleconferencing systems. These

are particularly useful to reduce the highly-structured procedures necessary in audio-only systems. Also they can eliminate the uncertainties of "who is present", "who is speaking", and "who wishes to speak", particularily if participants do not know each other well. (The "who" can be a name, a rank or a location).

Facilities to transmit and display these indicator signals should therefore be incorporated into audio systems. (The display of indicator signals could take the form shown in Figures 1 and 2, in Appendix A).

5.1.5 Open Microphone, Voice-Switched and Headset Facilities

Most presently available audio systems employ voice-switching at the terminals, to avoid acoustic feedback and noise problems which can result from use of open microphones at the terminals. However use of current voice-switched facilities irritates users because voice-switching results in chopping of phrases and loss of fractions of speech during a free-flowing conversation. (The problem is sufficiently serious with the DIAND System, that this organization has requested DOC to recommend alternate solutions, to be installed as soon as possible). The difficulties will be greater if one or more of the circuit connections is through a satellite. In this case, a phenomena known as "lock-out" will frequently occur during which voice signals cannot be received at all terminals. Conversation carried out using voice-switched multi-node teleconferencing facilities is only possible as a series of well-separated, deliberate monologues. This is not a satisfactory substitute for a face-to-face conversation.

It is of considerable importance to investigate all reasonable options which promise to restore to teleconferencing the naturalness of conversation possible with an open microphone terminal, but without the attendant acoustic and noise problems. Therefore, research directed towards improving terminals should be carried out. Without better terminals, teleconferencing conversations will continue to be unnatural substitutes for face-to-face conversations (Ref. 37).

5.1.6 Conference Bridging Systems

A highly desirable characteristic of any telecommunications system is the provision of facilities to allow rapid interconnection between terminals. A major complaint of users of presently-available federal government teleconferencing systems is the delay which can be encountered in providing conferencing connections. (Delays up to one half hour for completing the connection of all terminals are not uncommon). Therefore, carriers should make improvements in facilities for interconnection of terminals if they are to expect more effective use of this service. Preliminary assessment of the SL-1 Electronic Private Automatic Branch Exchange made by Northern Electric would indicate that it could be used to overcome such delays.

5.1.7 Required Supplementary Communications Systems

Facsimile should be provided as a necessary supplementary communications system for transmission of documents before meetings; telewriters and graphics transmission systems should be provided for special applications by some user groups.

5.2 ORGANIZATIONAL AND BEHAVIOURAL ADVANTAGES AND DISADVANTAGES

5.2.1 Organizational Advantages

Throughout this report, a number of claims have been made for the organizational advantages of teleconferencing. The principal claims have been substantiated by the interviews with users and field studies of systems in Canada (and those elsewhere). They are summarized below:

- Decentralization is facilitated,
- Freedom for locating physical facilities in remote locations is increased,
- Regional participation in decision-making is increased,
- Access to higher management levels is easier, improving staff morale,
- In some regions (such as Yukon and NWT) the teleconferencing system provides faster and more reliable access to outside locations than the telephone, because it uses dedicated lines,
- Key decision makers are brought together more quickly in natural or political emergencies,
- Low profile, when required,
- Components of large organizations may be knitted together more smoothly and completely,
- Meetings are relatively independent of weather and other travel constraints.

The principal organizational disadvantage is that security of communications can not be achieved, except at very high cost.

5.2.2 Behavioural Advantages

The behavioural advantages of audio teleconferencing have been identified in the user attitudes studies and supporting laboratory studies. Compared to face-to-face meetings:

- Meetings are shorter,
- Accuracy in the transmission of information is as high,
- Quality and direction of decision making is not affected,
- Speed of decision making is increased,
- Meetings are business-like and can be more democratic,
- Short, unscheduled meetings are facilitated,

- Subsequent face-to-face meetings may be more effective through better preparation via teleconferencing,

- Many regional debriefing sessions may be eliminated as more staff attend meetings.

5.2.3 Behavioural Disadvantages

Teleconferencing has a number of behavioural disadvantages which can restrict its effectiveness for many meeting tasks. When compared to face-to-face meetings:

- Meetings are less satisfactory for
  - forming impressions
  - generating ideas
  - resolving disagreements
  - getting to know someone
- Meetings are less satisfactory for negotiations
- Meetings are more tiring,
- Participants must concentrate harder,
- Meetings are less personal and more formal,
- Meeting procedures require some training and acceptance of the constraints of teleconferencing,
- Reduction of travel may be seen as a disadvantage by those who enjoy travelling,
- Lack of feedback.

In conclusion the behavioural advantages of teleconferencing permit it to be used satisfactorily for a high fraction of meeting tasks, but not for interpersonal socially-oriented tasks.

6. SUMMARY OF SITUATION REGARDING TELECONFERENCING

6.1 State of Teleconferencing Technology

All systems available today have technical deficiencies which restrict their usefulness. Some organizations, the University of Quebec for example, have initiated the development of facilities to overcome some basic deficiencies. Others, DOC, DIAND, and potential users of the TCTS or GTA telephone conferencing service and the Bell Canada Conference TV System for example,

are not using the facilities which have been available to them. Furthermore, implementation of systems in federal departments is proceeding in an uncoordinated and fragmented manner.

Research at CRC on an experimental audio system and developments elsewhere has shown that some highly desirable improvements are within the state-of-the-art, while others require further research and development. Improvements within the state-of-the-art are:

- improved conference bridging systems to provide automatic and reliable interconnection of terminals;

- provision of indicator signals to identify speakers and their locations, and thus reduce uncertainty of the presence of others;

- graphics transmission facilities, required for specialized use by some organizations, to supplement or substitute for facsimile transmission facilities.

Improvements requiring extensive research and development are:

- improved audio terminals with suitable conference bridging systems to permit free-flowing conversation, with provision to minimize acoustic feedback and line-noise problems, preferably without using current types of voice-switching systems.

Major research and development programs to improve audio teleconferencing systems have been virtually non-existent in Canada. It appears that the common carriers are not yet convinced that a large market exists, or if they are, then it is not identified as a high priority development. It also appears that the potential user organizations have not defined and demanded essential improvements within the current state of technology. The notable exception to this has been the University of Quebec which demanded and obtained some improvements to meet their basic needs.

6.2 ROLE OF SOCIAL SCIENCE IN TELECONFERENCING DEVELOPMENTS

Results obtained over the past three years have demonstrated the important role that social science can play in complementing technical research and development of interpersonal telecommunications systems. We believe that this will be increasingly important in the future. To help avoid repetition of costly errors, such as the hundred million dollar video telephone programs, the analysis of needs for new teleconferencing systems and the evaluation of proposed systems to meet these needs should be carried out by social scientists at a sufficiently early stage of development.

Data arising from the following studies would be required prior to decisions being taken on major development and installation of new terminals and systems.

- Studies to determine the acceptance and use of simple desk-top terminals compared with conference room terminals.

- Studies to determine the most satisfactory new types of audio terminals to replace current ones.

- Studies to define the desirable methods for identifying speakers and locations during meetings.

- Studies to determine the particular communication systems characteristics to meet the needs of various groups, and

- Recommendations on new forms of meeting procedures and the requirements for training for various types of communications activities.

- At a later stage, it will be necessary to have results from studies to predict the usefulness of integrating audio teleconferencing with computer conferencing and new image communications systems.

Finally, for future planning, it will be necessary to have social science input to studies which will consider the implications of a major growth in the use of teleconferencing or other related interpersonal telecommunications services. This growth will impact

- the patterns of communications developing throughout Canada,

- the characteristics of networks and systems,

- the use of other telecommunications services,

- the postal service,

- the transportation industry.

Currently, DOC has access to some of the few resources in Canada to carry out the range of behaviour/technical studies required to provide these recommendations. These resources include the laboratory established in collaboration with the PSC at their Management Training School in Carleton Place with government management personnel as research participants, and the laboratories of the Wired City Project at Carleton University. These laboratories have made significant contributions to teleconferencing. Other studies concerned with evaluation of user attitudes to teleconferencing have been carried out in collaboration with various Canadian organizations, within and external to government.

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8. REFERENCES

1. *Substituting Telecommunications for Travel: Feasible or Desirable?*, E.M. Van Vleck Proceedings of IEEE National Telecommunications Conference. San Diego Calif. 3 - 5 Dec., 1974.

2. *The Dispersal of Government Work from London*, Presented to Parliament by the Prime Minister and Minister for the Civil Service. HMSO (Cmnd 5322) June 1973.

3. *OECD Survey of Member Countries Activities in Telecommunications - Related Programmes in Energy Conservation.* RESTRICTED, OECD, Directorate for Science, Technology and Industry, Computer Utilization Group, DAS/CUG/74.52, November 1974.

4. *Transportation and Telecommunications: A Study of Substitution, Stimulation and Their Implications*, A.M. Khan. Canadian Transport Commission, Systems Analysis & Research Data Base Branch Report 121, June 1974.

5. *A Proposal to Provide a Teleconferencing System Between CRC and DOC/HQ*, G.W. Jull. Private Communication, November 1971.

6. *Teleconference Canada Research Plan.* SEB, DOC, August 1972. (Available on request from DOC).

7. *The Bell Canada Conference Television System*, E. Williams. CSG Report P/73137/WL, (sponsored by DOC) 1973.

8. *The Evaluation of Teleconferencing: Report of a Questionnaire Study of User's Attitudes to the Bell Canada Conference Television System.* E. Williams and Susan Holloway. CSG Report P/74247/WL, (sponsored by DOC) 1974.

9. *An Experiment in Conference TV.* B.C. Telephone Co. 1974.

10. *A Report on the Use of the Audio Conferencing Facility in University of Quebec*, J. Short CSG Report P/73161/SH, (sponsored by DOC). 1973.

11. *The University of Quebec Audio Conferencing System: An Analysis of Users' Attitudes*, H.B. Thomas and E. Williams. CSG Report P/75190/TH, (sponsored by DOC) July 1975.

12. *The Use of Audio-conferences (Teleconferences) in University Administration and Teaching*, J.S. Daniel, J.O. Fortier, and P. Simard. Presented at the Fourth Annual Frontiers in Education Conference, London, England, July 1974.

13. *La Telegestion a l'Universite du Quebec - bilan et perspectives*, R. Barrette and J.C. Kilfoil, Private communications, January 1975.

14. *Planning Research in Teleconferencing*, D. Havron and A. Casey-Stahmer. Report by Human Sciences Research, Washington (sponsored by DOC) June 1973.

15. *Technical Recommendations for Improving the DIAND Teleconferencing System*, N. Mendenhall and M.G. Ryan. Private Communications, October 1974.

16. *Remote Telecommunications Needs Survey Report*, N. Mendenhall. Private Communications for DIAND. January 1975.

17. *Attitudes Towards Changes in Communications Technology: The Introduction of Teleconferencing.* N. Mendenhall and J.G. Gartrell. CRC Report 1280, 1975.

18. *First DOC Interregional Teleconferencing System Meeting*, N. Mendenhall. Private Communication, 28 October 1974.

19. *An Augmented-Audio Teleconferencing System*, C.A. Billowes, H.C. Frayn, W.S. Tigges, M.A. Maclellan and G.W. Jull, CRC Tech Note 670, November 1974.

20. *Teleconferencing Studies: Behavioural Research and Technological Implications*, J.G. Craig and G.W. Jull, published in Proceedings of Seventh International Symposium on Human Factors in Telecommunications, Montreal, September 1974.

21. *Human and Technical Factors in Teleconferencing Services*, G.W. Jull and C.A. Billowes, (International Symposium on Subscriber Loops and Services), Ottawa, May 1974.

22. *The Need for and Acceptance of a Two-Node Audio Teleconferencing System in the Department of Communications*, N.J. Brown, N. Mendenhall and J.G. Craig. Private Communication, July 1974.

23. *The Influence of the Teleconferencing Medium and Status on Attitudes Towards the Medium, Attitudes Towards the Discussion, and the Participants Mood*, M.G. Ryan and J.G. Craig, presented at the Annual Meeting of the International Communications Association, Chicago, May 1975.

24. *The Influence of the Teleconferencing Medium and Status on the Aestheticism, Evaluation, Potency, Activity and Privacy of the Medium*, M.G. Ryan, presented at the Canadian American Communication Symposium, Buffalo, May 1975.

25. The Wired City Laboratory: Studies in Interactive Broadband Communications, D.C. Coll, etc. (DOC Research Contract SP2.36100-3-0365), 31 May 1974.

26. *Teleconferencing: A Comparison of Attitudes, Uncertainty and Interpersonal Atmospheres in Mediated and Face-to-Face Group Interaction*, J.R. Weston and C. Kristen (sponsored by DOC). February 1974.

27. *Teleconferencing: A Comparison of Group Performance Profiles in Mediated and Face-to-Face Interaction. Report #3*, J.R. Weston, C. Kristen and S. O'Connor. Contract OSU4-0072 (sponsored by DOC) April, 1975.

28. *An Evaluation of Audio Teleconferencing Systems LDK74,HTK71 and HMK74.* Bruce Christie, CSG Report, July 1974.

29. Williams, E., Unpublished Communications, CSG, 1974.

30. *A Quantitative Approach to Interpersonal Communication.* P.E. Allard, W.C. Treurniet, R.W. McCaughern and J.G. Craig, CRC Report 1271, April 1975.

31. *State-of-the-Art and Technology Forecast for Facsimile Terminals.* P.E. Allard and R.W. McCaughern. Private Communication, May 1975.

32. *Canadian Civil Servants Perceptions of New Forms of Communications Linkages*, A.D. Cameron and J. Langlois (presentation at 18th International Congress of Applied Psychology. Montreal, June 1974.

33. *Systemes de Teleconferences: Leurs influences sur la disposition du groupe.* M.G. Ryan et N. Mendenhall (Presente au 43ieme Congres de l'Association Canadienne-francaise pour l'Avancement des sciences, Moncton, mai 1975).

34. *Educational Telephone Network and Subsidiary Communications Authorization: Educational Media for Continuing Education in Wisconsin*, L.A. Parker, Educational Technology, February 1974.

35. Proceedings of the Seventh International Symposium on Human Factors in Telecommunications, Montreal, September 1974.

36. *The Description and Classification of Meetings*, R. Pye, B.G. Champness, H. Collins and S. Connell, CSG Report P/73160/PY 1973.

37. *Speech Band Teleconferencing Terminal Development*, G.W. Holbrook, Private Communication, November 1973.

38. *An Assessment of Travel/Communications Substitutability*, L.H. Day, Futures, December 1973.

APPENDIX A

Desired Characteristics of a Federal Government System

A.1 GENERAL SYSTEM DESCRIPTION

The results of our technical and behavioural research over the past three years have led to the following preliminary specifications for an effective teleconferencing system. This section deals, firstly with a general system description, and secondly with a summary of tentative system specifications. Finally initial estimates of numbers of terminals and their costs are given along with allocation criteria.

A.1.1 Terminals

Two types of terminals will be used in the system, teleconferencing (T/C) room terminals (Type A) and T/C desk terminals (Type B).

1. *T/C Room Terminals (Type A):* These terminals will normally be permanently placed in an acoustically treated conferencing room. This type of terminal is shown in Figure 1. The largest rooms will accommodate ten participants to be identified and ten participants in a support role.

2. *T/C Desk Terminals (Type B):* These terminals will be so designed that they can be rapidly moved into or permanently installed in offices which will not be acoustically-treated. These terminals may also be placed in work locations, telephone-type kiosks, etc., as required. A Type B terminal would normally be used by one person but could be used by up to four participants. Figure 2 shows a suitable implementation. Type A and B terminals will be provided with facilities for:

(i) transmission and reception of voice signals of acceptable quality,

(ii) transmission, reception and display of indicator signals used to indicate (a) presence of principal participants, (b) identification of a participant who is speaking and (c) identification of participants who wish to speak, and

(iii) allowing the conference chairman to override a speaker and take control of the voice channel.

A.1.2 Transmission Facilities

Communications control and conference bridge subsystems will be provided for:

(i) interconnection of Type A and/or B terminals for the duration of a conference,

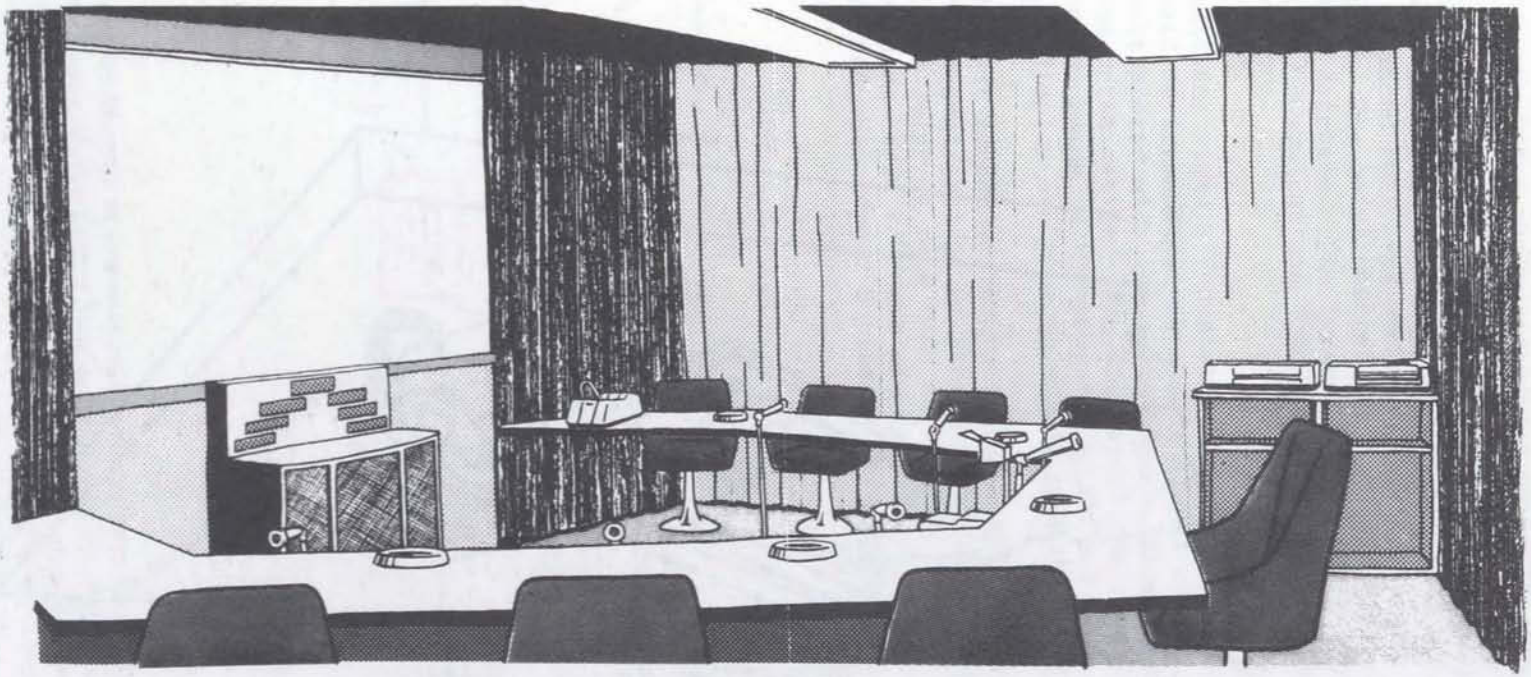

Figure 1. An Artist's impression of a room terminal (Type A). Each participant has a microphone and there is a large display on one wall.

Figure 2. An Artist's conception of a terminal which could be placed on a desk (Type B). It involves a CRT display showing the person speaking (Evans, two people who wish to speak (Debois, Walker) and the total number of participants at the meeting (17).

(ii) continuous monitoring of the quality of lines and restoration of defective lines, as required, during a conference, and

(iii) controlling the transmission of indicator signals.

Figure 3 illustrates a possible hierarchy of communication control systems. It is possible that the city/regional and master controls system would be an advanced switching machine presently under development by the common carriers. The local control system could be a microcomputer utilizing special purpose software. The interconnection between control systems could be the Computer Communications Network and utilize software developed for that system.

The indicator signals (speaker identification, presence signals, wish to speak) would be transmitted as a data signal either on a separate data channel or multiplexed with the audio signal, depending on the plans for overall system optimization. The display of the signals at each terminal would be based on human factor considerations and technical constraints as far as mode of display and time to signal changes are concerned.

A sufficient number of terminals and number of circuits in the network would ensure the availability of the teleconferencing service for up to four locations with a delay of less than 15 minutes for 90% of the time for the busy hour based on coast to coast service. However up to 16 locations could be interconnected when longer notice is given (A.1.3, A.4.4).

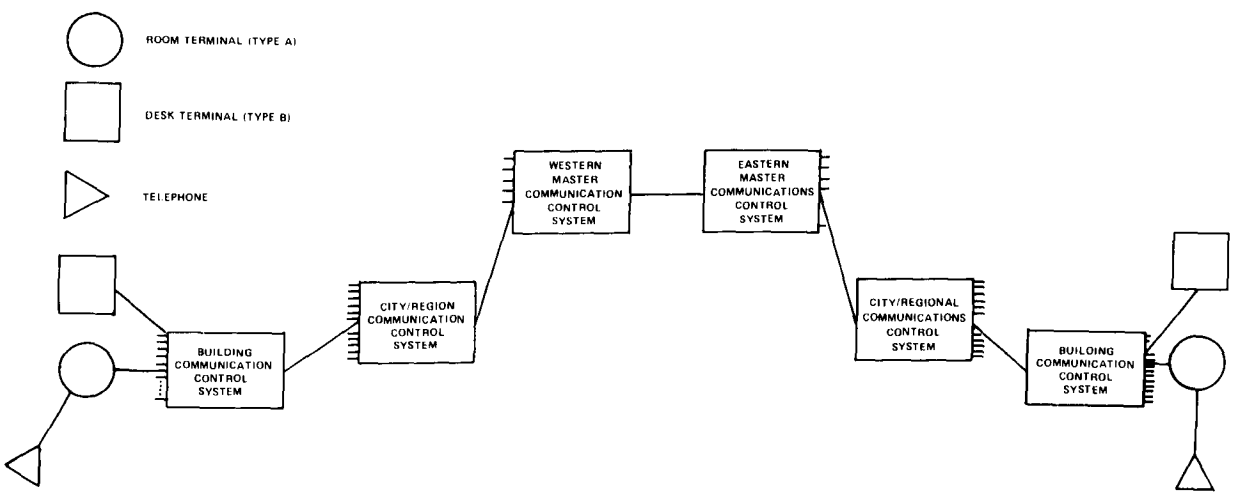

Figure 3. A possible hierarchy of communication control systems for a teleconferencing network. City/Region & Master Communication Control Systems could be advanced digital switching machines, presently under development for telephony applications. The local communications control system could be a microcomputer with special purpose software. It is possible that the communications control systems will be connected using the computer-communications network, and utilize software developed for that purpose.

A.1.3 Booking of Teleconferencing Service

Teleconferences would be booked through secretaries for a particular desired period. Large meetings (up to 16 locations) would be booked more than one-half day in advance. However, access to the teleconference service by up to four groups would be possible with a maximum delay of 15 minutes for 90% of the time based on the Trans-Canada busy hour. Automatic interconnection of locations would be possible using the local Communication Control System. This would be operated by teleconferencing switchboard operators. There would also be the facility for particular locations to drop out of the conference, including the originating location.

A.2 TECHNICAL CHARACTERISTICS OF TERMINALS AND LOCATIONS

The acceptance of teleconferencing by the subscriber would depend to a very large extent on the technical characteristics of the terminal and how these characteristics affected the users' behavioural patterns. A tentative system specification is outlined in Table A1 at the end of this section. Some of the parameters have been verified by experiment, while the others have been deduced, and require experimental verification as indicated in notes to the Table.

A.3 NUMBER OF TERMINALS

The CSG (Communications Study Group in the UK) have stated that a good estimate for the number of room terminals required to serve a large population can be obtained by assigning, on average, one terminal to every 200 people. Therefore, approximately 1500 room terminals are required for the federal government with 350,000 employees. We assume that one desk unit, on average, should be assigned to every two senior executive level personnel, which results in approximately 1500 desk units being required. This leads to a total of 3000 terminals to serve the federal government teleconferencing needs. For DOC alone, the number of terminals required is 20 (ten room and ten desk).

A.4 ALLOCATION CRITERIA, AVAILABILITY AND ACCESSIBILITY

The actual distribution of the 3000 terminals within the federal government would not be uniform. The provision of terminals to various groups and individuals would be determined by

(i) a federal government office communication survey, to identify the frequency and/or priority of communications requiring intercity travel,

(ii) a terminal type allocation decision, based on an analysis of (i), and

(iii) a requirement for accessibility and availability of terminals for an effective service.

It would also be possible to estimate the circuit requirements between switching centres from the data obtained from (i), (ii) and (iii).

A.4.1 Communications Survey of the Federal Government Offices

The federal offices across Canada would be listed and the groups within these offices which conduct frequent meetings involving travel would be identified and projected to 1980.

A.4.2 The Terminal Type Allocation Decision

The allocation decisions would be based on communications tasks, responsibility of individuals or groups requiring immediacy of communications, communications frequency and geographic location. The communication survey must provide inputs for the allocation criteria listed below:

Allocation Criteria (Interim List)

a) the number of intragovernment business trips for meeting purposes within a group should exceed three per month and/or the number of intragovernment telephone calls that involve more than two people for meeting tasks are greater than two per week,

and/or b) the responsibility of the individual or group for activities involving travel is high, even though the business trips are limited,

and/or c) the "immediacy" of communications offered by teleconferencing is required for the type of work carried out by the group (crisis management, impact on work of group caused by unforeseen travel constraints).

and/or d) the geographic location of the group is such that travel is usually constrained (e.g., Yellowknife, Whitehorse).

A.4.3 Accessibility and Availability of Terminals*

Given that one or more of the above criteria are met for a particular group, a sufficient number of Type A terminals would be so located that all potential participants would be required to walk no more than 100 metres (or two floors) from their usual work location to have access to a teleconferencing terminal. If common-user conference rooms were not available in the work locations of the group or individual, Type B terminals would be provided in offices and in, or near, work locations.

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* *It is to be noted that a teleconferencing facility has characteristics of availability and convenience of access that are similar in some respects to those of meeting participants. Behavioural research suggests that the convenience of access to a facility and availability of the facility are important factors in determining the utility of teleconferencing.*

A.4.4 An Estimation of Circuit Requirements Between Switching Centres

The probability of many simultaneous teleconferences between major centres in Canada must be considered in order to determine the required number of circuits between these centres. CRC studies of 200 users of the

Bell Video Teleconferencing System have shown the average length of a teleconference meeting to be 2.2 hours*, and that 5% of meetings exceed 3 hours duration. For example**, if there is a high probability that 10 simultaneous teleconference meetings are being held, involving participants in Ottawa and Toronto, up to 10 circuits must be provided between these centres in order to ensure the availability of the service with delay of less than 15 minutes.

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* *For audio teleconferencing, this figure has been found to be 1.2 hours for room terminals (Ref. 13) and 0.3 hours for the conference telephone (Section 2.3.2.1).*

** *For example, it has been estimated that an average of up to 100 man trips per day may be substitutable by teleconferencing. Assuming 25% of trips originate from Ottawa, and on average, two man trips per meeting, a daily average frequency of teleconferencing from Ottawa locations of more than 10 teleconferences is highly probable.*

TABLE A1

Technical Characteristics of Terminals and Locations

A summary of desirable characteristics of a teleconferencing system are presented below, (some of these characteristics are not within the current state of technology).

Item		T/C Room Terminal (Type A)	T/C Desk Terminals (Type B)	
1. Frequency Response*		3 dB points 300 Hz & 3.3 kHz; ± 1 dB in band ripple	3 dB points 300 Hz & 3.3 kHz; ± 1 dB in band ripple	(Note 1)
2. Harmonic Distortion		< 3%	< 3%	
3. a. Signal to Noise Ratio*		> 30 dB	> 30 dB	(Note 2)
b. Impulse Noise*		< 1 strike every 5 minutes	< 1 strike every 5 minutes	(Note 2)
4. Sound Level		70 dB SPL at each participant	70 dB SPL	
5. Microphone Configuration*		open microphone	open microphone	(Note 3)
6. Distance from Microphone		1 – 10 feet or as defined by cupola design	1 – 5 feet or as defined by cupola design	(Note 4)
7. Room Reverberation Time		200 -- 500 msecs or as defined by cupola design	not applicable	
8. Variation of signal level between different circuits during a meeting*		< 3 dB	< 3 dB	(Note 5)
9. Room Return Loss*		⩽ -24 dB (with respect to ambient received sound level)	⩽ -24 dB (with respect to ambient received sound level)	(Note 6)
10. Terminal Connection		4 wire + data channel	4 wire/2 wire	(Note 7)
11. Data Rate	Transmit	1200/4800 bits/sec	30 bits/sec	(Note 8)
	Receive	1200/4800 bits/sec	100–1200 bits/sec	

* *Indicate items requiring experimental verification as indicated in the notes.*

12. Indicator Signals	Receive	Presence Indicator Speaker Identification Wish to Speak	Presence Indicator Speaker Identification Wish to Speak	
	Transmit	Presence Indicator Speaker Identification Wish to Speak	Presence Indicator Wish to Speak	(Note 9)
13. Display of Signals		Common and/or individual with all details as far as names etc. are concerned. Display is alphanumeric	Individual but in less detail than for Type A. Display is alphanumeric	(Note 10)
14. Number of Nodes*		16	16	(Note 11)
15. Number/Node*		Up to 10 identifiable positions	1 identifiable position but provision for up to 4 positions all together	(Note 12)
16. Interconnection*		via Communications Control System (CCS)	via CCS	(Note 13)
17. Other facilities		Interactive graphics, slow scan television, facsimile, telewriters.	Interactive graphics, slow scan television	(Note 14)

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* *Indicate items requiring experimental verification as indicated in the notes.*

REFERENCE NOTES FOR TECHNICAL CHARACTERISTICS PROVIDED IN TABLE A1

Note 1. It is desirable to have a flat frequency response to alleviate acoustic feedback problems. However this is a tentative specification, in that the effects of band-limiting on voice quality and "presence sensation" have not been evaluated. Further research must be carried out in order to verify this specification.

Note 2. The effect of different noise levels (signal-to-noise ratios) has not been assessed. It is necessary to evaluate
(i) the threshold of annoyance due to line noise,
(ii) the tolerable limit of impulse noise hits, and
(iii) the level of background acoustic noise from any room.

Note 3. A room will have
(i) acoustic conditioning, open microphones and loud speakers, or
(ii) a collection of audio cupolas (that is, small acoustically-treated enclosures with built-in loudspeakers).
As an office will not be acoustically-conditioned it is necessary to use an audio cupola, an earpiece, or some other means to minimize the need for voice switching and prevent acoustic feedback. As far as the room is concerned, the relative technical and behavioural merits of (i) and (ii) must be established. This will have a bearing on Note 6.

Note 4. The variation is to accommodate different room sizes.

Note 5. This is to ensure that the sound levels received from participants at each location are approximately equal. The effects of relaxing this parameter must be investigated.

Note 6. Room return loss is defined as

$$10 \log_{10} \left| \frac{\int_0^{t_r} \{S_e(t)\}^2 \, dt}{\int_0^{t_r} \{S_{l.s}(t)\}^2 \, dt} \right| \leq -24 \text{ dB}$$

Where t_r = reverberation time of the room

$S_e(t)$ = signal received by the microphone(s) when an impulse is fed to the speakers

$S_{l.s.}(t)$ = impulse response of the speaker(s)

The return loss depends on the number of conference locations connected. If the number of locations is reduced, then this requirement can be relaxed. On the other hand, a room return loss of -24 dB may be too low for satellite channel echo delays (0.5 sec

and 1.0 sec). As yet there is no technical means of achieving this level of loss in a room without using "close-miking" (i.e. talking with a microphone placed very close to the mouth of the participant). This is undesirable and other means of achieving this loss must be found.

Note 7. It is proposed that both indicator signals and graphics information should be transmitted over a separate data channel except on the local connection between the Communication Control System and a desk terminal. On a local connection 2 wires or 4 wires may be used to provide full duplex service.

Note 8. The data rates for room terminals include provision for the transmission and reception of some graphics information. Lower data rates could be used if only speaker indicator signals are transmitted and received. The data rate from a teleconference desk unit to a Communications Control System can be quite low as a participants name or his address code can be inserted at the Control System. However, the "wish to speak", "presence" and other signals must be sent from the terminal. Messages from a particular Communications Control System to all teleconference units depend on the degree of sophistication and storage capabilities of desk units. If there is sufficient storage capabilities at a desk unit to store the ASCII characters corresponding to a speaker's identification, a data rate of about 1000 bits/sec is required. On the other hand, if a desk unit is capable of storing the names of up to 50 participants and their corresponding address codes, a simple addressing scheme could be used at a data rate of 100 bits/sec. (A desk unit with no storage capabilities needs continuous data sent at a much higher data rate to provide a flicker-free display).

The final choice will be based on economic trade-offs between sophisticated desk units, and the cost of supplying a high speed data channel.

If data signals from conference rooms (Type A) and desk terminals (Type B) are concentrated at Communication Control Systems, before being transmitted to teleconference units, data rates must be chosen to ensure that time delays in reception of indicator signals are less than 0.25 secs.

Note 9. For terminal Type A, the detection and transmission of indicator signals will be performed in the T/C room by an algorithm capable of detecting which participants are speaking at that terminal.

On the other hand, for the T/C desk terminal (Type B), the detection and transmission of indicator signals can be performed by the Communications Control System.

Note 10. The common display in the T/C room should continuously display the names of all participants currently present at the meeting. The individual display would indicate the person(s) speaking, up to four participants who wish to speak, total number of participants at the meeting, and any lines that had become defective. The names of

participants who have left the meeting will be displayed for a short time to indicate their departure. The ergonomic and economic trade-offs of the various display options must be evaluated.

Note 11. The behavioural and technical feasibility of interconnecting up 16 nodes must be examined to determine if the behavioural effectiveness of the system decreases with increase in the number of nodes. (This may have a major impact on the usefulness of the desk terminal for large meetings).

Note 12. This is the maximum number of participants that can be identified at each terminal. The total number of identifiable positions in a meeting with many nodes should be less than 50. Note that no speaker identification is available for three extra participants at a desk terminal. The feasibility of displaying the names of 50 participants and its interrelationship with items 14 and 9 must be evaluated.

Note 13. Optimum methods of interconnection must be sought (e.g. one computer shared or microcomputers in terminals or both).

Note 14. The possible inclusion of these extra services should be considered in deriving design philosophies for the terminals. No cost estimates for their inclusion are provided in this study.

A P P E N D I X B

Expenditures on DOC Teleconferencing Project

CRC Project Costs (CRC Operational Plans 1972-1975)

Year	MY	G&S ($) ($000's)	Capital ($) ($000's)
1972/73	6.5	34	47
1973/74	4.4	79	66
1974/75	10.0	55	44
TOTAL COSTS	20.9	168	157

Estimated SEB (SPPB) Costs

Year	MY	G&S ($) ($000's)	Capital ($) ($000's)
1972/73	3.	60	-
1973/74	3.	60	-
TOTAL COSTS	6	120	-

Teleconferencing Total Costs (CRC and SPPB) 26.9 (MY)

$288,000 (G&S) and $157,000 (Capital)

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8. ABSTRACT: Volume 1 presents summary results and conclusions arising from a three-year study of the potential of teleconferencing, as a means to improve the effectiveness of communications within federal government departments. Volume 2 provides detail information on the results of this study. It has been found that teleconferencing is feasible and can be very useful as an aid to communications between decentralized units but all available systems have major technical limitations which make them unsuitable for federal government use.

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