APPENDIX C-EXHIBIT 1

ENVIRONMENTAL IMPACTS OF COCA-COLA BEVERAGE CONTAINERS

(By Arsen Darnay and Gary Nuss)

PREFACE

The report examines and compares the total environmental impact associated with the manufacture, filling, and disposal of various beverage containers. Total environmental effects were evaluated and compared for eight different beverage container material systems. The study concept was conceived by Harry Teasley of Coca-Cola USA and articulated and executed by Midwest Research Institute.

Volume I is a summary of the study results. It describes in brief the research methodology and the study assumptions. Volume I contains comparisons of the eight container systems in each of the major environmental categories and includes the study team's speculations and judgments on the research findings.

Volume II is a detailed presentation of the rationale and calculations involved in arriving at estimates and measurements of the effects of each container system on the environment. Volume 11 contains individual chapters on each material system. These chapters include details on rationale, calculations, and data sources.

Principal researchers for MRI were Mr. Arsen Darnay and Mr. Gary Nuss. Additional contributions and research support and assistance were provided by Dr. Edward Lawless, Mr. Paul McNergney, Mr. Donald Heiman, Dr. Eugene Vandegrift, Mr. William Park, Mr. James Cross, and Miss Linda Crosswhite.

The authors wish also to acknowledge the aid and assistance of the beverage container manufacturers who provided data and perspective for the research effort--Chattanooga Glass Company, Owens-Illinois, Alcoa, Reynolds Aluminum, Monsanto Company, B. F. Goodrich Company, American Can Company, and Continental Can Company.

Approved for: Midwest Research Institute.

JOHN MCKELVEY,
Vice President,
Economics and Management Science.

INTRODUCTION

In the spring of 1970, Coca-Cola USA asked Midwest Research Institute to study the total environmental impacts caused by the production, use, and discard of beverage containers used by the company.

This assignment was the result of a staff study conducted by Coca-Cola USA headed by Mr. Harry E. Teasley, Jr., Product Manager, Packaging. The staff study was an exploration of the ways in which Coca-Cola's containers affected the environment. One conclusion of this study was that the interactions between the company's container systems and the environment represented a complicated set of material and energy transfers. The handling of beverage packages as components of solid waste was only one of many such transfers and possibly the least important one.

The Coca-Cola study team also concluded that information sufficient to inventory all major materials and energy transfers necessary to produce, fill, deliver, and dispose of beverage containers was not readily available but could probably be obtained.

Finally, the team concluded that an effort to create this body of information would be useful and enlightening and would create a better understanding of the total environmental impacts caused by beverage production and consumption.

Midwest Research Institute was asked to meet two objectives in its environmental study of beverage packaging and distribution:

1. To establish the total environmental impacts created by the use of each of several selected container systems available to Coca-Cola USA; and

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2. To compare the impacts of various types of containers under the assumption that each container type is used exclusively for Coca-Cola packaging.

The report presents MRI's conclusions. The study is a "first" in environmental research. In it, we attempt to give a "total" environmental profile of several products, showing all major material and energy transfers that can reasonably be identified. To the best of our knowledge, such profiles have not yet been developed for any other group of products, although the concept presented here and the method followed will, we believe, be widely used in the future to introduce environmental considerations as a new element in commercial and industrial planning.

RATIONALE AND APPROACH

The why's of environmental analysis

Pollution control in the conventional sense--the treatment of industrial effluents before discharge-is already a major new cost item in industrial practice. The national drive toward environmental cleanup, however, is now beginning to expand into novel directions. For one thing, the so-called "third pollution," solid waste generation, has been discovered, and proposed solutions to the waste problem include the recovery of wastes for industrial use, the reduction of waste generation at the source, and the raising of (revenues for waste disposal by imposition of disposal taxes on manufactured goods. For another, the fundamental connection between consumption and pollution is now common knowledge, and the curbing of consumption is viewed—rightly-as a simple way to arrest environmental deterioration.

These "new directions," if followed, mean a restriction of corporate freedom to act and higher operating as well as administrative costs. Industry, as a whole, appears willing to accept a reasonable limitation of its sphere of activity for environmental reasons-with emphasis on ***reasonable.*** But industry representatives are understandably anxious that in the sound and fury of our rush to clean up air, water, and land, reason will be the first casualty; and when the dust settles, industry will find itself fettered-while the environmental problems will still be with us.

At this point in time, the "good life" provided by industrial civilization conflicts with the ideal of a clean environment at many points. Pollution arises from fossil and nuclear fuels whose conversion in machines and use in production, transportation, communications, lighting, and heating is the foundation of the good life. Dispassionately considered, the environmental issue is an invitation to find a new balance between two "goods"—the good life and the good earth. A clean environment under medieval working conditions would be unacceptable to most. On the other hand, the good life is disappointing if it must be lived on a blighted globe.

A reasonable approach to the environmental issue must balance the various, and often conflicting, values we wish to increase. An indispensable prerequisite for such an approach is knowledge-knowledge of the environmental impacts created by our activities and the values we must give up in order to minimize those impacts.

Industry's best insurance against hasty legislation and intolerable strictures on its activities is to create understanding of its role in delivering values to the public—as well as the environmental insults that accompany such delivery. To do this is a tall order: it requires a high degree of objectivity and institutional maturity. Self-analysis, if honest, always runs the risk of finding fault. But ultimately, it is to industry's benefit to participate in the environmental debate in an objective manner. Only such participation can guarantee that a reasonable balance between our various needs can be established.

This study is an exercise in self-analysis. It is an answer to the question posed by one company : "What is our contribution to environmental pollution ?"

Study approach

This study concerns itself with the use of containers in Coca-Cola product distribution. Beverage production is one of the cleanest industrial operations. Few pollutants and little waste reach the environment from the filling plant. But beverage production requires large quantities of containers whose manufacture generates pollution, and the containers are ultimately disposed of as solid waste after a single or multiple use.

Coca-Cola USA wanted to know not only the environmental impacts caused in the beverage packaging and distribution phase of its operations but also the nature and magnitude of impacts caused on its behalf by others. Two specific

aspects of Coca-Cola operations—the raising and harvesting of products that become beverage components and the production of syrup-were excluded from the analysis.

The approach adopted was that of tracing a beverage container "back" through the various fabrication, processing, and mining/extraction steps necessary for its manufacture and delivery to the filling plant, to study its behavior in the filling plant itself, and then to trace it "forward" into consumption, discard, and disposal operations. Analysis of returnable containers also required a look at the "return loop" whereby these bottles are brought back to the filling plant for repeated use. A return loop was also studied in analyzing the environmental impact of aluminum cans under various assumed rates of recycling of obsolete aluminum cans.

We selected the measure of 1 million beverage units (fillings) delivered to market as the analytical base. Next, we traced eight container systems (five proven and three experimental) through nine operations, and within each operation we looked for eight specific environmental impacts. The study approach is depicted conceptually in Figure 1.

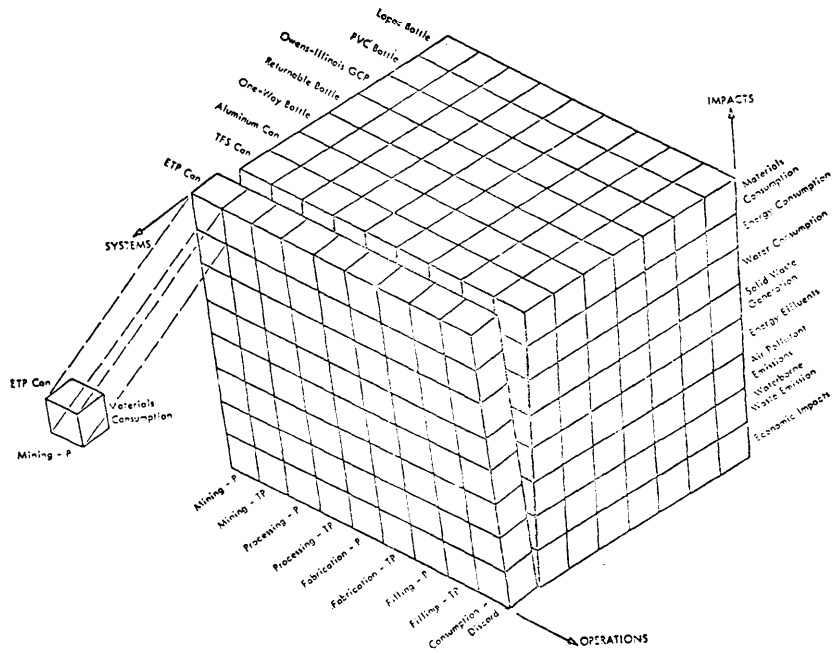

Figure 1 - Research Concept

Container systems.—Three metal containers, two glass containers, a combination glass-plastic package, and two plastic containers were selected for analysis: the electrolytic tin plate steel can (ETP can), the tin free steel can (TFS can), the aluminum can, the one-way glass bottle (OWB), the returnable glass bottle (RB), the Owens Illinois GCP container, a polyvinyl chloride (PVC) bottle, and the Monsanto Lopac plastic bottle.

Because data from Coca-Cola on filling and distribution operations were available only for 12-fluid-ounce-capacity cans and lo-fluid-ounce-capacity glass bottles-which in fact compete for market shares on an equivalent basis—these sizes only were studied and compared. Filing and distribution data on the GCP, PVC and Lopac containers were not available; these are experimental systems; in our calculations, we assumed that they would behave in the same way as one-way glass bottles.

Impacts measured.--The basic thrust of the research was to measure impacts on atmospheric quality, water quality, and on land (in the **form of solid** waste generation). Two additional measures, however, were also introduced: impact

on natural resources, measured in terms of materials and energy consumed, and impacts on foreign trade, measured in terms of import levels required for a given container system.

Following our research and analysis, we found that data could be presented, more or less accurately, in the following eight impact areas:

1. Materials consumption, including all materials needed for making the product but excluding water and fuels.

2. Energy consumption, broken down by type of fuel and by point of use (i.e., mining, processing, fabrication, filling, and in transportation associated with these activities, and with disposal). Energy consumption is uniformly shown in million British thermal units (Btu).

8. Water use, by point of use, given in 1,000 gallons.

4. Solid waste generation, including mining wastes; processing, fabrication, and filling wastes; and discarded containers as waste.

5. Energy effluents, including airborne particulate matter, nitrogen oxides, hydrocarbons, sulfur oxides, carbon monoxide, aldehydes, and other organics, and lead.

6. Air pollutants emitted in processing and fabrication, excluding pollutants generated by combustion of fuels.

7. Waterborne wastes generated, excluding such wastes as are generated in mining operations, which are included with mine tailings.

S. Economic impacts that result from waste management and the purchase of materials from foreign countries.

***Operations analyzed.—The* initial study design called for the analysis of seven specific operations which together represent the total beverage container production-use-disposal system: mining/extraction, processing, fabrication, filling, retail distribution, consumption, disposal, and transportation steps between operations.**

In the metal and plastic container sectors, processing is a multistage operation which could be broken down into a number of processing steps. In the glass sector, processing and fabrication are combined into a single operation. In spite of these differences, we retained the original operation breakdowns for mining, processing, fabrication, and filling. But we found it more practical in dealing with environmental impacts to combine all operations after filling into a single "consumption-disposal" category. Finally, we treated transportation between operations as a special operational step throughout. Thus, in this report, impacts are measured in the following operations: Mining-Process, Mining-Transport, Processing-P, Processing-T, Fabrication-P, Fabrication-T, Filling-P, Filling-T, and Consumption/Discard-T.

The study results are quantitative, Impacts caused by the delivery to market of 1 million fillings in various containers are shown in measurements appropriate to the impact. We were not asked and made no attempt to establish what damages or hazards are caused by various pollutants emitted; we only recorded the quantities produced in such a manner that the container systems can be compared to each other.

Methodology

The methodology used is discussed in detail in the Appendices where detailed data are presented. Discussion of methodology in general terms is impractical because of the multiplicity of actions that have to be explained—which is best accomplished with direct reference to the data used. However, some comments on procedure can be generalized.

Analysis began with a determination of the physical components of each container and closure, by weight, and the gross quantity of each required as input into the container manufacturing plant for a given unit of container output. This information was provided by container manufacturers.

Next, the number of containers required to deliver 1 million fillings of beverage was determined from data provided by Coca-Cola.

These two sets of data were then combined to establish the total processed materials required as inputs to the container fabrication operation.

Analysis of the materials processing operations resulted in information on the types and quantities of raw materials needed at each processing stage per unit of output, and processing input requirements represented quantities of raw materials that had to be mined or extracted in mining operations.

Consumption of energy per unit of output in the various operations was determined either from census data or from industrial sources. **Data were obtained**

by type of fuel or energy consumed; these data were expressed uniformly in million Btu using published conversion factors. Energy consumption data per operation output unit were multiplied by the number of units needed for 1 million fillings to yield total energy requirements.

Water consumption data were obtained in the same way as energy data.

By using national transportation statistical sources (Interstate Commerce Commission data for rail and truck movements and U.S. Corps of Engineers data for barge traffic), the average distance that various commodities are moved by transportation mode and the percentage of tonnage moved represented by each mode were established. Data on movement of containers to filling plants, from filling plants to retail outlets, and the movement of empty containers to disposal sites were determined from company sources and from other published reports.

Next, total ton-miles of movement by transportation mode and total fuel consumption, by type of fuel, per ton mile were established from national statistics, so that average energy consumption values in transportation could be used.

Data on transportation energy consumption between various operations were calculated by multiplying tons of materials required for 1 million fillings by average distance moved by mode and by average energy consumption per ton-mile. In addition to commodity and product movements, of courses, the weight of packing also had to be taken into consideration to obtain realistic values.

Using federally sponsored research reports on air pollution generation, energy effluent factors were established by unit of fuel combusted in various stationary and mobile conversion/combustion units. These factors, multiplied by energy consumption in the various operations and transportation steps, resulted in the measures of energy effluent generation.

Assembly of data on (1) mining, processing, fabrication, and filling waste production; (2) waterborne waste generation; and (3) airborne waste generation (other than energy effluents) depended on a large number of data sources, some of them corporate, some federal research reports, some statistical sources such as the Bureau of Mines annual reports. In some cases, waste generation was estimated based on analysis of materials balances in the processes involved.

Where a container and its closure consisted of more than one material, separate studies of each material had to be undertaken and combined to yield a total for the container system.

Study Limitations

To establish the total environmental profile of products is a new departure in product analysis. Such studies, until the present, would have served no valid commercial purpose. Not surprisingly, therefore, few if any companies have the reporting systems that can deliver information to make environmental judgments about their products.

This state of affairs required MRI to seek information from many different sources, published at different times, using different bases. Many information elements needed were not available in published form and had to be gathered by personal visits to companies. Much of the effort was devoted to the assembly of necessary data and information and to the reconciliation of conflicting information and information referring to different time periods. Some of our data came from industry surveys, some from conservation with two or three companies. Some corporations, because of the nature of their industry, could not reveal information on their operations, and we were forced to estimate impacts by analogy with other industries or by selecting an impact level from a wide range of reported impacts.

For these reasons, the data presented here should be viewed as good approximations of the truth but subject to revision as better information becomes available.

Information on the experimental container systems is understandably more sketchy than on the established packages. Among established packages, data on aluminum containers were taken almost entirely from published sources since industry representatives could not reveal operating data; such data are considered proprietary.

Study Assumptions

Research of the type conducted here, where problems of data accuracy, absence of information, and other analytical difficulties have to be dealt with, must necessarily make use of assumptions to allow completion of the work. We consider

the assumptions used extremely important in qualifying the findings and so wish to make them explicit at the outset.

Geographical scope.—Since the **environment by definition includes all of inner and to some extent outer space, this study could not have been completed unless geographical boundaries had been set for impact measurement. Thus, we assumed that only those environmental impacts would be measured which occur within the boundaries of the Continental United States. Thus, for instance, mining wastes generated and energy consumed in mining iron ore or bauxite in a foreign country for import to the U.S. are not reflected in impact measurements.**

Operations measured.-In addition to a geographical boundary, we also set an operational boundary, assuming that only those impacts are measured which **occur in *direct*** connection with an operation involved in the production, use, and disposal of containers. Thus, energy consumption, pollution and waste generation, and water use are measured for mining iron ore, fluxing limestone, and coking coal necessary for pig iron production. But the same impacts are not measured for the mining of coal burned to generate electricity which is, in turn, used in mining and processing of raw materials and the fabrication and filling of cans. Impacts related to the production and delivery of fuels are considered ***indirect*** impacts and are not reflected in the analysis.

Materials exclusions.--Our work would have been unmanageable if we had been required to trace the impacts of all materials necessary for the production. delivery. and use of beverage containers. Materials used in small quantities such as tin in ETP cans; chromium in TFS cans; feldspar and other minor materials in glass manufacturing: plastic gaskets in closures: inks, lacquers. and sealents in can production : and packing materials of all kinds were simply added to the total weight that had to be handled: they were not traced back to their origins.

Transportation assumptions.—Several assumptions were made concerning transportation, as follows:

1. Rail.—Whi1e electrical power is reportedly used to power some rail movements, we made the simplifying assumption that all rail movements were diesel **powered.**

2. *Truck.—We* assumed that all truck transport, except that used in filling and disposal, would be provided by both diesel and gasoline powered vehicles in proportions as experienced nationally for both inter- and intracity movements.

3. ***Filling transport.—Data*** **provided by Coca-Cola were assumed to be representative** for each type of container. It was assumed that cans are transported to warehouses by diesel truck and from warehouses to retail establishments by gasoline truck. We assumed that experimental containers on which data in filling transport were unavailable, would move in the same way as the traditional container they most resembled--this Lopac and PVC like the one-way bottle, the GCP like the cans.

4. ***Retail to point of consumption.--We*** did not attempt to measure transportation requirements from point-of-purchase to point-of-consumption nor, where applicable, the transportation required for returning empty, returnable containers to retail outlets by consumers.

5. Disposal movement.—Based on surveys conducted by Combustion Engineering Company, we assumed that all solid wastes moved 6.5 miles and that this movement was by gasoline powered truck.

Electrical energy.—As a simplifying step, we assumed that all electrical energy used in any part of the beverage system comes from coal, oil, natural gas, and hydroelectric facilities in proportions as experienced nationally. Also, in measuring electrical energy consumption, we used as ameasure 10,600 Btu per kilowatt-hour [1]—the fuel energy required to generate this unit of energy on a national basis—rather than the theoretical equivalent value of a kilowatt-hour, 3,413 Btu.

Since aluminum production consumes proportionately more hydroelectric prover than all consumers of electricity, our assumption may seem to overstate, slightly. the quantities of fuel consumed in aluminum production and the quantities of pollutants emitted as a consequence of fuel combustion for electrical generation. This point is discussed further below.

Size equivalency.--Since data from Coca-Cola on filling and transport operations were given to us for 12-ounce cans and 10-ounce bottles and. furthermore, because these two types of containers compete on an equivalent basis in the marketplace, we assumed that they are equivalent for purposes of environmental comparison, in spite of the fact that on a unit-by-unit basis more liquid is delivered in cans than bottles in this case. The data presented. of course, can be used

[1] Derivation of this value is presented in Appendix A, volume II, of this report.

to express equivalency between quantities **of liquid delivered, in which case** fewer-cans are used and the environmental impacts of the can systems would be proportionately lower—approximately ten-twelfths or 17.7 percent.

Trippage.--Based on Coca-Cola's experience at the time of initiation of this work, we assumed that returnable bottles make an average of 15 trips before either breaking or being rejected as no longer serviceable. Consequently, one returnable container is equivalent to 15 nonreturnable containers in the impact analysis.

Plastic containers.—In the cases of beverage containers made of conventional materials--steel, glass, aluminum-processing steps and material requirements are defined largely by the particular material used. This situation does not exist with plastic containers. A particular plastic material may be derived from several different raw materials and by several different processes.

Ethylene is a starting material for both the GCP polyethylene cup and the PVC bottle. In the U.S. most ethylene is derived from liquid hydro-carbons--ethane or propane-extracted from natural gas; moreover, most **plants to be built** in the future will probably also be based on ethane-propane given current conditions.[2] Since the study team obtained direct manufacturer's data and experience on ethylene produced from propane feedstock, our analysis of ethylene production is based on propane as a feedstock.

Lopac is a proprietary polymer developed by Monsanto Company; and due to its newness and the company's proprietary interests, data on specific Lopac processes and requirements were not made available to MRI. Our analysis, therefore, is based on analogous processes and materials.

Monsanto recommended that Lopac monomer production be based on acrylonit rile production and that Lopac polymer production be based on PVC polymerization processes. These suggestions were incorporated into our analysis.

Acrylonitrile is produced from a propylene feedstock, and propylene may be derived either as a by-product of gasoline manufacturing operations or from ethylene production from propane feedstock. Although most propylene is obtained from gasoline operations, our study assumes the propylene required is a **by-product of ethylene produced from propane. This assumption places Lopac on the same basis for material requirements and mining-extraction impacts as the other plastic or plastic-containing systems.**

To obtain the propane feedstock for conversion to plastic raw materials requires two processing steps which are classed as mining-extraction operations for this analysis. The first step is recovery of natural gas from the gas field ; the second step is extraction of propane from the natural gas at a natural gas plant. In the latter operation various airborne effluents are generated and emitted from the process; although these effluents are the same types as the effluents from energy consumption, they are classified as mining wastes since they are process wastes occurring in the mining-extraction operation.

One drawback to the use of PVC—in any type of packaging--is the formation of hydrogen chloride (HCI) when PVC is incinerated. Because of this particularly noxious effluent and the difficulties it creates in incinerators, the study team concluded HCI should be included in the energy effluents total for PVC. Since roughly 14 percent of the nation's solid waste is incinerated, 14 percent of the waste PVC going to disposal was considered to be incinerated. This ratio was used to estimate total HCI emissions from the incineration of PVC wastes generated by the **manufacture** and use of 1.01 million containers. These effluents were included as "energy effluents" in disposal operations rather than as "process wastes" **because it was felt that the** HCI emissions should carry a weight of 0.4 instead of 0.1.

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[2] Of the two materials, propane has had an economic advantage over ethane because of by-product credits. **In addition, propane is more easily transported than ethane, although an** ethane feedstock gives a **greater yield of** ethylene.

APPENDIX C—EXHIBIT 2

AUTOMOBILE POWER SYSTEMS EVALUATION STUDY

STATEMENT OF OBJECTIVES

As part of its continuing efforts to assure that the best possible automotive power systems are made available on an appropriate time schedule, Ford Motor Company is awarding a study grant to support independent research studies and technical appraisals of potentially promising alternatives to the internal combustion engine.

The overall objective of these evacuations is to provide independent, objective guidelines for achieving and maintaining optimum vehicle characteristics with respect to national needs and desires for clean air, conservation of non-renewable natural resources, improved safety and general betterment of mobility and quality of life within an affordable economic framework.

A concomitant general objective of the evaluations is the proper timing of actions relating to power system changes—the research and development lead-times for various propulsion alternatives, time-phasing of logistical support and infrastructure development, feasible rate schedules for large-scale conversion to alternative systems, etc. In other words, the overriding questions relate not to *what can be done,* but to *what should be done and when* in order to gain significant advantages over today's internal combustion engine and its logical and likely evolutionary derivatives. It is expected then that comparisons of all alternatives will be made against a moving baseline of timely improvements and extensions of present engine technology. For all comparisons, the time-frame of greatest interest is the decade 1980-1990, but study attention must extend well beyond this period to comprehend such things as resource availabilities including potential for different fuels; full-conversion evaluations and economic implications.

Specific objectives with respect to each admissible alternative course of action would include the following:

A. An engineering appraisal, including identification of operational characteristics and parameters, of major unresolved technical considerations, including time and cost estimates for their probable resolution.

B. A determination of the earliest feasible and practicable large-scale conversion of vehicles to the system, with an estimate of the most reasonable conversion rate.

C. An assessment of the probable total aggregate economics, natural resource, environmental and societal impacts Of the conversion, including production, logistic and energy support requirements. Here, explicit attention should be directed to forecasting and bounding future motor vehicle use, taking into account changed land use policies, new life styles and the probable increased availability of public transportation.

D. An overall comparative evaluation in relation to forecasted internal combustion engine technology, including the engine improvement information that has been provided to the National Academy of Sciences.

E. Explicit development of manufacturing costs for major system components, treating them parametrically where costing uncertainties so dictate. Here, extensive use of sensitivity testing would be indicated to define cost targets critical to decision choices.

F. Categorization of research and development requirements into tasks that logically call for either government funding or industry funding, depending on the size of commitment time for payback, recipient of the benefits, probability of success, etc.

During the course of this effort, Ford will make available information on present internal combustion engine technology to the extent that such information would not be prejudicial to any patent or proprietary interest. Ford will also make available alternate engine information such as that already provided to the Environmental Protection **Agency and the National Academy of Sciences.**

Our parallel efforts to forecast technology and socioeconomic and environmental factors will not be made available in order to avoid introducing an appearance of bias or lack of objectivity in the study.

Finally, it is our desire that the results of the study be made available to the public in published form without prior editing or approval by Ford Motor Company. The product is the sole responsibility of Cal Tech JPL.

APPENDIX C - EXHIBIT 3

1975 GENERAL MOTORS REPORT ON PROGRAMS OF PUBLIC INTEREST

[To obtain a copy of the full report, write to: General Motors Corp., Detroit, Mich. 48202.]

APPENDIX C-EXHIBIT 4

TECHNOLOGY ASSESSMENT IN BELL CANADA [1]

(By Lawrence H. Day, Assistant Director—Business Planning, Bell Canada)

INTRODUCTION

The **information in this report outlines the process and activities associated with technology assessment (TA)** in Bell Canada. This material is presented to the Technology Assessment Board of the U.S. Congress in the belief that the sharing of these experiences will contribute to the continuing dialogue on the value of TA. The following views should be considered as the author's opinion of how TA is conducted in Bell Canada, and not considered as a formal statement of corporate policy.

The report begins with a brief introduction to Bell Canada. The function of the author's organization in Bell Canada, the Business Planning Group, is elaborated in some detail since this is the Group that has conducted or sponsored the major TA activities in Bell Canada. The document continues with a review of some of these activities, with special emphasis placed upon our work in the substitution of telecommunications for travel, and its resultant impacts. The next section deals with a current review of the social impacts of a new electronic polling service that the corporation is currently considering. The last part of the paper will review some of the lessons we have learned in the past four years, and the author's opinions of where TA will fit in the future in both Bell Canada and the corporate environment in general.

BELL CANADA AND THE PLANNING GROUP

BELL CANADA

Bell Canada is Canada's largest provider of telecommunications services. It operates as a corporate entity in the Provinces of Ontario and Quebec. Other key organizations in Canadian telecommunications are described below. Bell Canada operates in association with the Trans-Canada Telephone System (TCTS) for the provision of nationwide telecommunications services. The TCTS is composed of eight organizations (Bell Canada, three Bell owned or controlled, three owned by Provincial governments, and one a subsidiary of a U.S. corporation, General Telephone). The TCTS competes nationwide with CN-CP Telecommunications in the voice, data, and visual telecommunications businesses. Other organizations include TeleGlobe Canada, the Federal Government owned carrier for overseas telecommunications, and Telesat Canada which is a joint public-private corporation for the provision of satellite telecommunications within Canada.

Bell Canada is Canadian owned and controlled and is not associated with the American Telephone and Telegraph Corporation. Bell Canada owns its own manufacturing organization. Northern Telecom. Northern Telcom. is not a captive supplier in the traditional sense, Bell owns 62 percent of the shares **but only buys slightly** more than 50 percent of Northern's output. The rest is **sold to other Canadian and foreign firms. including over $100 million in sales in the** U.S. Bell Canada and Northern jointly own Bell-Northern **Research which** is **Canada's largest industrial research organization. Another key subsidiary is Tele Direct** which handles Directory (Yellow Pages) sales and publication in Canada. Consolidated operating and sales revenues for Bell Canada in 1975 were approximately $3 billion.

[1] Much of the material in this document has been published in previous Business Planning reports and papers. The publications list in Appendix 3 is provided to keep references to internal documents to a minimum.

THE BUSINESS PLANNING GROUP (BPG)

BACKGROUND

Forecasting has been an established function at Bell Canada and the telecommunications industry for many decades. In the past however, forecasting has been oriented toward identifying both customer demand patterns and technological change. The BPG was created in the mid-1960s to conduct new forms of research and planning, not to duplicate or consolidate any existing planning or forecasting function in Bell. Within the context of a rapidly changing environment, it is the BPG's objective to position itself through research, information collection, and analyses to be capable at all times of advising decision-makers on possible future business opportunities, threats, and their impacts on the corporate environment. The opportunities and impacts that concern the Business Planners are those that might arise through technological, economic, social, or market developments in the intermediate (5 to 15 years) and longer term future.

The Group's mission and approach to its research may be delineated further through a brief examination of some of the project areas and techniques used to conduct these various analyses. One area of research is a multifaceted examination of the potential of future trade-offs between travel and communications. This research examines the technological, economic, behavioral, energy, environmental, and government policy issues associated with the substitution question. Another project reviews a similar range of issues associated with potential social impacts of "wired city" services. Both of the above two areas will be examined in more detail in the review of Bell Canada TA activities. Other areas of concern involve evaluation and testing of various approaches to computer conferencing and future '{paperless offices" (described briefly below). All of these **projects, and others not discussed here, have involved the use of a variety of techniques and support capabilities that are important in the BPG's research. Several are described below.**

TECHNIQUES AND RESEARCH AREAS

TREND EXTRAPOLATION

Perhaps the most basic form of futures research in many business planning efforts involve the use bath of regression analysis and judgmental trend projections. Sample areas explored include expected changes in the Canadian gross national product (GNP) to the year 2000, corporate revenue and expense components, Canadian energy trends, and computer market trends. One project involved using the concepts of "S" curve forecasting for products and services in the early and rapid stage of growth. This overall concept utilized the idea of diffusion growth of services or products throughout an industry from an initial pace-setter.

THE DELPHI APPROACH

Six major **Delphi studies have been conducted by the BPG. Over 215 panelists explored the future of education, medicine, business information systems, and future communications systems in the home. The main thrust of these studies was to identify emerging trends and changes that would have an impact on needs for visual and computer communications. The studies were market-oriented and forecasted the adoption of various services at defined threshold levels. Market adoption and not technological breakthroughs was the prime criterion used. Each of the forecasts was presented in a social framework developed by the Delphi panelists. Various structural and social changes expected in the relevant professions considered were also forecasted.**

SPRITE (SEQUENTIAL POLLING AND REVIEW OF INTERACTING TEAMS OF EXPERTS)

This is a new methodology developed by the BPG that modifies the Delphi process as originally defined by the RAND Corporation. SPRITE utilizes the concept of controlled debate and feedback to uncover impacts resulting from the uses of technology. Here consensus is not a goal as it is in Delphi studies. The panelists offer assessments that are presented from the point of view of an interest group. These views are not summarized in overall study averages but remain independent for counter analysis by other interest groups. Hence, SPRITE is a valuable tool for TA studies. The methodology was applied to two studies of future communications into the home. The services examined included Shopping from the

Home, Checkless Banking, Programmed Education, Home Security Services, and ten forms of information retrieval service that could be used in the home.

SURVEY RESEARCH

The BPG has used survey research in a number of its projects. For example, a large scale survey of business travelers was conducted to provide behavioral data for a project on the potential of long term trade-offs between travel and communications services.

CROSS IMPACT ANALYSES

The technique of cross impact analysis has proved to be a valuable aid in explicitly stating assumptions of the interrelationships and interdependencies in the development of new forecasts. The technique is used to represent relationships of variables in a complex environment, and present the summary in a meaningful fashion. Recent experience enables us to identify four major attributes of the technique: (1) an educational process takes place in the garnering of data since people must think over complicated relationships in a structured manner; (2) a communication process takes place since answers are usually obtained by having several panelists in the same room vote and discuss their answers; (3) a summarization process takes place after the data has been gathered since many people's opinions on various topics are mirrored back to them on one matrix, thus enabling the drawing of conclusions using this one matrix as a reference; and (4) a computer-based sensitivity analysis can be run on the data to simulate the influence of sudden changes in policy. This can lead to counter-intuitive results that provide new perspectives for decision-makers.

Of course, the ultimate limitation of cross impact, and indeed any Delphi-like process, is the accuracy or inaccuracy of the raw data. However, benefits that should be expected are the possibilities for education, communication, and summarization of complex policy environments often found in interdisciplinary research. The BPG has studied the cross impact technique extensively, and has published several critical documents on its potential for futures planning. The group has also applied the technique in several of its major TAs. Cross impact analysis has also been used by the group to analyze several corporate policy issues. This involved the use of a specially prepared computer analysis package. The BPG has also assisted several Canadian government departments and corporations in the use of cross impact analysis.

The above paragraphs describe several techniques used for technological forecasting and assessment. The BPG also uses powerful computer support tools as well. The "Paperless Office" trial is an important example.

THE "PAPERLESS OFFICE" TRIAL

NLS (the On-Line System) is a concept conceived over ten years ago at the Stanford Research Institute (SRI). In 1973, the BPG became the first corporate organization to agree to subscribe to the NLS experimental system. The BPG now participates as a real-world user and has undertaken an extensive assessment of the system from the user and social point of view.

The NLS is a highly refined information retrieval, text editing, electronic mail, and teleconferencing system designed to aid the "knowledge worker" by facilitating the rapid organization and preparation of text-based information. The system's ideal, as originally conceived, is to "augment the human intellect". The system provides a means through which information can be more readily generated, processed, and retrieved. Ideas are exchanged in an ongoing mode, with a shared data base of journals, reports, and projects that are available to all NLS participants.

Members of the BPG, both the professional and support staff', have direct access to NLS through terminals located in the BPG offices. Portable terminals are also available to facilitate working from remote locations, that is, working from the home or from distant cities. In addition to using NLS for daily office functions (report writing, memo storage, message sending, etc.), the BPG is using NLS to build its internal computerized data base, which supplements the shared NLS data base of a broader scope.

THE STAFF

An examination of the formal training of the various Business Planners shows that Group members have a wide variety of educational backgrounds. This in-

eludes advanced degrees in business administration, electrical engineering, marketing, political science, public administration, arts, computer sciences, linguistics, and economics. Regardless of the educational backgrounds of the individual planners, they are all encouraged to be generalists. Hence the approach to problems is from the point of view of a generalist rather than a subject specialist. In addition, specialized skills in various technical, behavioral, and legal areas are obtained on a consulting "as required" basis rather than through permanent hiring. Past experience has shown that these specialists tend to become cut off from their parent disciplines if they become full-time planners. This is often to the disadvantage of both the Group and the individual. One slightly unusual aspect of **BPG staffing is the fact that many group members have degrees in business administration. This is not common for technological forecasting and assessment or futurist groups but it has resulted in a healthy generalist atmosphere in the Group.**

TECHNOLOGY ASSESSMENT IN BELL CANADA

INTRODUCTION

The TA work at Bell Canada was initiated by the BPG in 1972. At the time, this was regarded" as a logical extension of the technological forecasting activi***ties*** underway in the Group. This extension was undertaken at the initiative of the Group management rather than under specific direction from senior management. This was not unusual since the vast majority of Group projects have been initiated internally rather than assigned to the BPG. The broad mandate of the organization has encouraged this approach to technological forecasting and assessment.

The definition of TA that has been used is one of the accepted ones in the TA profession. Our shorthand definition is that TA is the advance identification of the secondary impacts that often arise from the uses of technology. Our more formal definition has been the one presented by Vary Coates:

"Technology assessment is the systematic identification, analysis, and evaluation of the real and potential impacts of technology on social. economic, environmental, and political systems and processes. It is concerned particularly with the second and third order impacts of technological developments; and with the unplanned or unintended consequences, whether beneficial or detrimental, which may result from the introduction of new technologies or from changes in the utilization of existing technologies. Technology assessment seeks to identify societal options and clarify the tradeoffs which must be made; this approach is designed to provide an objective and neutral input to public decisionmaking and policy formulation with regard to science and technology." [2]

BPG has undertaken TA activities in four areas. The actual work ranges from projects that follow a rigorous TA methodology to those that are involved with exploring fundamental interactions between telecommunications and other sectors of society. These activities are:

(a) The study: A Technology Assessment of Computer-Assisted-Instruction Use in Colleges;

(b) Exploring the societal impacts of proposed wired city services;

(c) Exploring future trade-offs between travel and communications services;

(d) Sponsoring research into the impact of new telecommunications services on native Copulations of the Canadian North ;

The first three of the above studies were conducted using internal professionals with outside support where required. The final study was contracted with Queens University of Kingston, Ontario and was monitored by a BPG professional. This report will concentrate on the first and third studies. The Computer Aided Instruction (CAI) study will be referenced since it was the first TA conducted by the Group and used the most widely known methodology, the MITRE approach. The Group has been interested in trying out a variety of methodologies in its TA activities since it is clear that there is no approach that enjoys widescale approval as the "right way" amongst the professionals associated with the field. The CAI study is summarized below. The work in travel-communications substitution takes up the bulk of this descriptive section on BPG-TA activities.

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2 Vary R. Coates, Technology and Public Policy : The Process of Technology Assessment in the Federal Government. Summary Report, Program of Policy Studies in Science and Technology, The George Washington University, Washington, D.C., July 1972, p 1.

This study represents the most formal and extensive TA conducted by the group to date. This study had two prime objectives:

To illustrate a methodology that will be of use in future TAs.

To assess potential societal impacts of CAI in post-secondary institutions.

The primary objective was undertaken to determine what methodologies were available to conduct structured TAs. The group had been involved in extensive technological forecasting activities in the educational field for several years, and through these efforts and the acquisition of data from many outside research organizations had developed a large educational data base. It was obvious that more than this action was required to conduct a TA, and that a methodology was needed to organize a TA project. The initial phase of the CAI project was concerned with a Search for a TA process. The approach outlined by Mitre Corp. in their research for the Office of Science and Technology (Executive Office of the President) was selected as one that would serve our needs.[3]

CAI was selected as a subject of study for a number of reasons. Bell Canada had financed research and trials of systems in the educational technology field. The Business Planning group had also conducted two extensive Delphi studies exploring the future of educational technology. Part of this research was conducted with McGill University in Montreal as part of a graduate thesis research program, and this choice of subjects matched their interests as well. Finally, the field is one that has been the center of many controversies and grand promises in the last decade. This study was designed to bring all of these issues into a common perspective. The steps followed in the CAI study are outlined below. Since the Mitre methodology was used here. it is useful to list the seven basic steps followed in this process:

1. Define the assessment task;
2. Describe the relevant technologies;
3. Develop the state of society assumptions;
4. Identify the impact areas;
5. Carry out a preliminary impact analysis;
6. Identify possible action options;
7. Carry out a complete impact analysis.

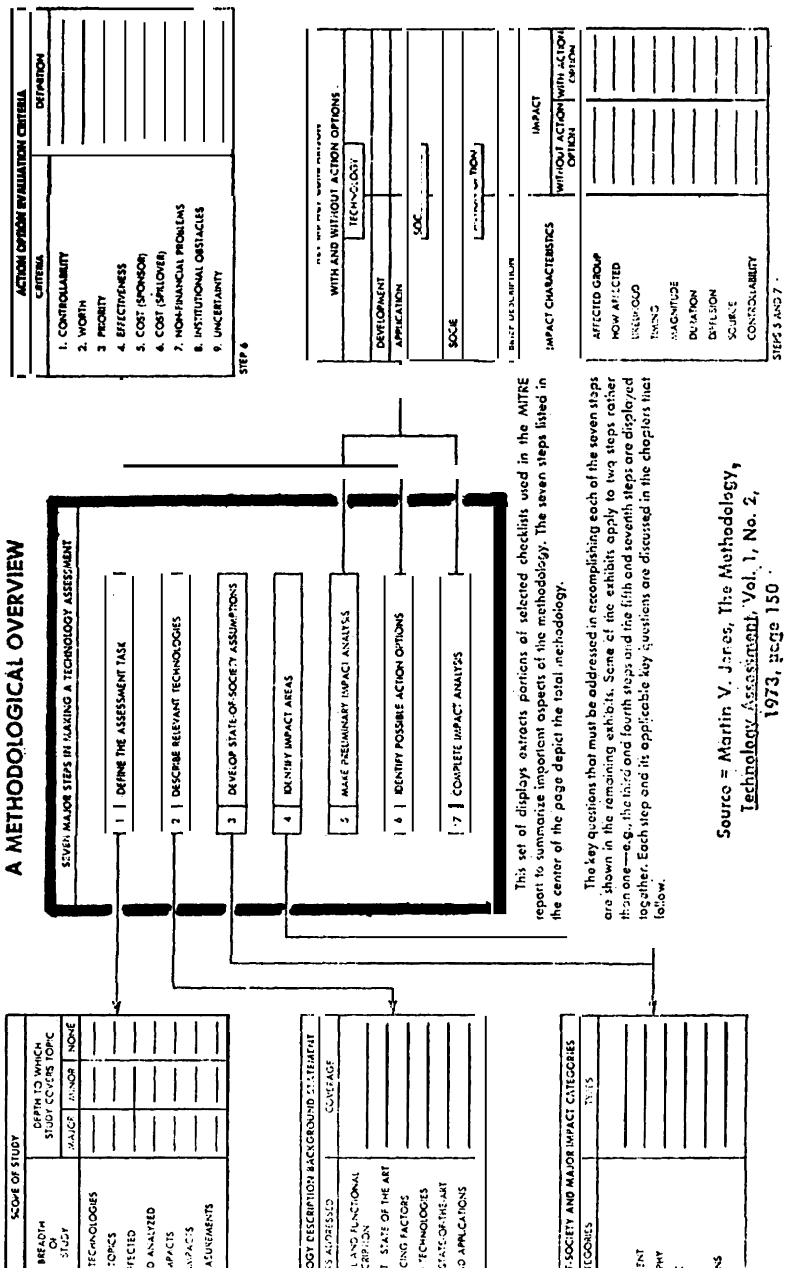
The MITRE approach is shown in figure 1. This figure also illustrates the forms used **in the various steps of the TA, which** were also adopted by the **BPG.** The approach used in each of the seven steps in the CAI study will now be examined.

1. ***Define the assessment task***

Definition of the scope of the study was an important first step. Initially the researcher had the entire field of educational technology as his scope of interest. Areas such as computerized library systems, information retrieval television, audio-visual terminal development, and chemical learning were excluded from the scope of the study in order to make the analysis manageable. **The scope was restricted further to the use of CA I in post-secondary institutions rather than attempt to cover its us? across the various school levels, industry, and research institutions. Four groups that would be affected more than any others in society by the introduction of CAI were selected for the action and impact analysis; students; professors; colleges; and industry. The study was a future-oriented, technology initiated one. The impacts discussed were social, economic, or institutional in nature.**

[3] Martin V. Jones. A Technology Assessment Methodology : Some Basic Propositions, Volume 1, The Mitre Corporation, Washington, 1). C., June 1971.

FIGURE 1
TECHNOLOGY ASSESSMENT:
A METHODOLOGICAL OVERVIEW



This set of displays extracts portions of selected checklists used in the MITRE report to summarize important aspects of the methodology. The seven steps listed in the center of the page depict the total methodology.

The key questions that must be addressed in accomplishing each of the seven steps are shown in the remaining exhibits. Some of the exhibits apply to two steps rather than one—e.g., the third and fourth steps and the fifth and seventh steps are displayed together. Each step and its applicable key questions are discussed in the chapters that follow.

Source = Martin V. Jones, The Methodology, Technology Assessment, Vol. 1, No. 2, 1973, page 150.

2. Describe the relevant technologies

This section relied on input from two sources. Firstly, the two Delphi studies on the future of educational technology conducted by the BPG were used to provide common definitions and a forecast data base. Secondly, the report produced for the U.S. Congress by the Committee on Public Engineering Policy that explored the societal impacts of CAI was used for some scenario inputs and some general technical limitations statements.[4]

The Bell Delphi studies were used to provide inputs on the cost-benefit ratios that would be required for CAI adoption at the various school levels, for descriptions of future related technologies, for forecasts of future hardware and software, and for the various potential applications of CAI.

3. *State of Society Assumptions*

The state of society assumptions were developed from the Bell Delphi data base as well. The areas explored were future trends in Canadian value systems, the business and economic environment, the institutional environment, and the relevant social factors.

4. *Major impact categories*

The categories selected for further evaluation were the business (economic), institutional, and social impacts of the widespread introduction of CAL The researcher concluded that the impact of CAI on future values would be difficult to determine at this time.

"In the **case of CAI, though value assumptions set the stage for widespread use, it is difficult to foresee any changes in values resulting from this single technological development, at the present time."** [5]

5. *Preliminary impact analysis*

The process used was as follows:

"The primary impact is traced from its source to its ultimate effect on a certain social group. The primary impact in turn, becomes the source of the secondary impact. Because the second-order effect will occur only if the first-order event has taken place, probabilities of secondary consequences are always lower than the likelihood of corresponding primary effects.

The impacts presented are quoted substantially from a pilot TA commissioned by the Committee on Public Engineering Policy. Forecast dates of the Bell Canada Delphi's are incorporated and impact characteristics are quantified." [6]

The following sixteen impacts were selected for examination in this analysis:

—increased costs;
—improved construction;
—physical plant modification;
-closer ties between schools;
-restructuring of curriculum;
--extended day, week, and year;
—standardization and centralization;
-coping with poorly prepared students;
—impersonal education;
—individualized instruction ;
—aid for minority-group students;
—student-instructor relationship;
—modification of instructor's role;
—new copyright protection;
—industry-controlled education;
—development of industries and products.

6. Identify possible action options

Phases 6 and 7 of the MITRE methodology were completed during the second part of the CAI study. The researcher shifted his focus from secondary research to that of original data collection. His objective was to **obtain an independent, Canadian evaluation of the possible impacts of the options for various actions. The study design used group judgmental data** from a number of Canadian experts on the various aspects of CAI system design and use, This

[4] **Study of Technology Assessment Report of the Committee on Public Engineering** Policy, **National** Academy of Engineering, **Government Printing Office, Washington, D.C.,** 1969.

[5] **Philip** Feldman, A Technology Assessment of **Computer-Assisted-Instruction**, Business Planning Group, Bell **Canada**, Montreal, Quebec, **August 1972, p. 1S.**

[6] **Ibid., p. 21.**

was **a specialized survey rather than a Delphi study since there was only one round of the questionnaire and no interaction between the respondents during the study. However, the survey was not a normal one in the statistical or market research sense since the respondents were not selected from a random sample. They were selected from earlier panelists on the business planning Delphi study on educational technology, and from a list of members of an educational technology committee of the National Research Council of Canada. The final group of respondents represented a cross-section of individuals from the teaching profession, university administration, educational research organizations, government departments, and industry. Each potential respondent was given a copy of the report outlining the preliminary analysis (steps 1 to 5) and each had received copies of the Delphi material.** Hence, the respondents were working from a common data base and were well-aware of the use of their inputs.

The initial concept was to complete a sixty-ceil cross-impact analysis. However, this was too great a task through which to put any volunteer respondent. The researcher decided to choose **the** most important action options and impacts, and to work out **a** modified impact matrix. The probability of the selected impacts and actions occurring in the next ten years was evaluated first by the panel.

7. ***Final impact analysis***

This was obtained from the replies of the CAI-TA panel assembled by the researcher. As noted above a reduced matrix was constructed. This is shown with the final estimates of the societal impact of the CAI in figure 2.

The final reduced matrix was analysed by the researcher who developed the following conclusions:

"Though (figure *2)* does not examine every conceivable action and impact related to CAI the data clearly indicates that few unfavorable societal consequences will result from widespread use of CAI in colleges. In fact, it appears that almost all parties will benefit from the proliferation of CAI systems. Students, whether they are at the top or bottom of their classes, will benefit because of increasing individualized instruction. Professors will benefit because they will be liberated from the mundane chores of reinforcing knowledge. Finally, industry will benefit because of new education related business opportunities. In order to maximize the favorable effects mentioned above, we will now recommend that certain action options be undertaken. Since the ultimate purpose of a **TA is to delineate actions whose execution will influence projected events in a socially responsible manner, the following recommendations constitute the most important segment of this TA:**

Governments should legislate new types of copyright protection.

Development of a common author language should be encouraged.

Colleges should examine the feasibility of introducing professional incentives for programmed materials.

There should be greater co-operation between colleges and industry including the institution of CAI programmer consultant services.

Professors should use CAI as a supplement rather than a substitute." [7]

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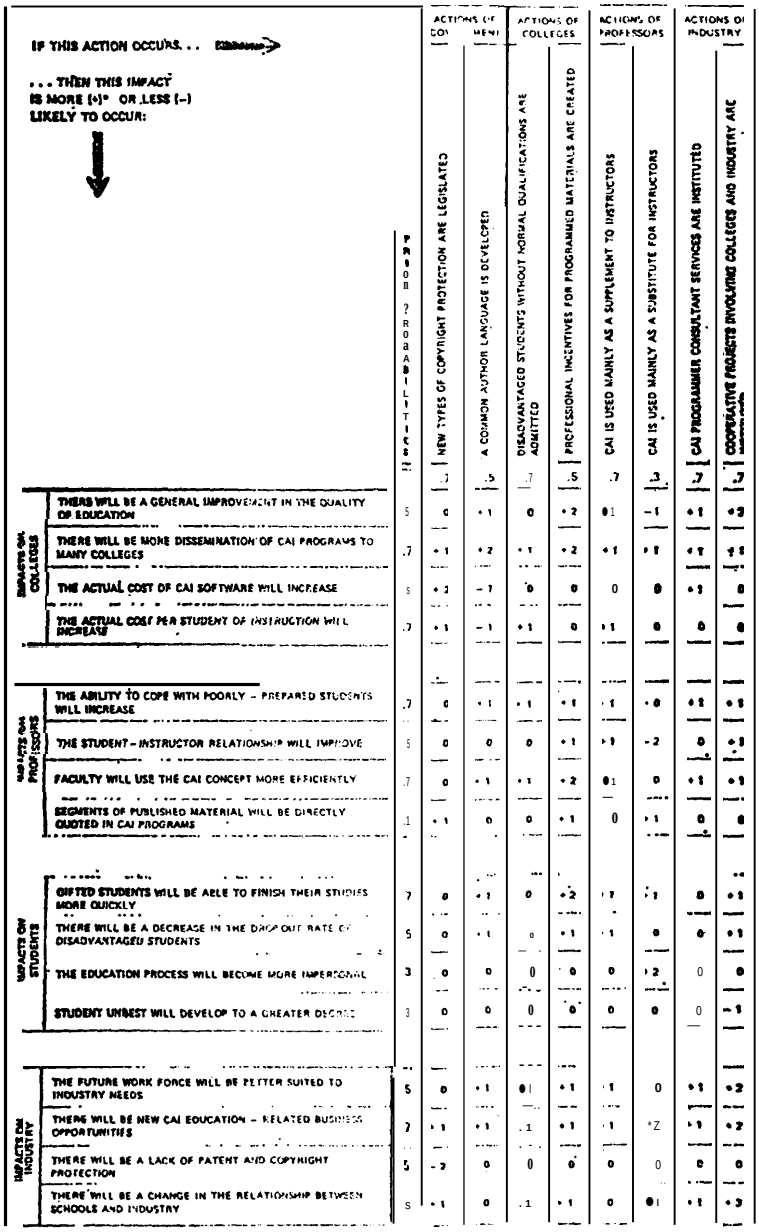
[7] **Ibid., p. 03.**



SUMMARY OF REVISED CAI SOCIETAL IMPACTS

FIGURE 8.

* A positive sign (+) indicates the effect of the occurrence of the summary development will be to increase the likelihood of occurrence of the summary development, and a negative sign (–) indicates the converse. The strength of the impact is indicated by the following code: 0 = no impact, 1 = minor impact, 2 = Strong impact, and 3 = Very strong impact. (Source: Enzer)

TECHNOLOGY ASSESSMENT OF TRAVEL-COMMUNICATIONS SUBSTITUTION

INTRODUCTION

This area is one that has captured much of the attention of the BPG in the past five years. A variety of projects have addressed issues associated with the potential of future communications services to substitute, supplement, or interact in some way with the transportation sector. In total, these activities add Up to a multi-faceted TA of the various social, political, environmental, energy, behavioral, and corporate impacts of the interaction of travel and communications. The Group has never collected all of these studies into one big report and called it a TA. However, we feel that both the spirit, techniques, and scope of the research justify its inclusion in a review of our TA activities, The work in this area has been concentrated in a number of projects. The key areas are outlined below:

.4 continuing assessment of the technologies that are the driving forces in the telecommunications fields. These will not be discussed here but are summarized briefly in Appendix 2.

A detailed behavioral evaluation of the individual traveller's perception of travel and communications and his or her attitude towards the substitution of certain types of travel with telecommunications alternatives.

An examination of the energy implications of travel-communications substitution.

A review of the policy implications of substitution across a wide spectrum of activities.

Participation with SRI's recent National Science Foundation (NSF) sponsored TA of Travel—Communications Substitution.

The BPG has never attempted to replicate or "Canadianize" related research in other relevant countries and fields. The approach has been to build on and expand from the base of available research. Hence, in the narrative that follows, references will be made to the work of others were it is important to the understanding of our TA activities in the substitution field. It should also be noted that the discussion below should only be considered a superficial introduction to a research area that is becoming one of the most popular in the telecommunications impacts field.

The focus on substitution is significant since it emphasizes one of the impacts that will develop from the uses of communications systems in both current and projected forms of social interaction. This is a shift from earlier research that examined various communications systems such as audio or visual teleconferencing and postulated that one of the uses of a particular system might be some impact on travel activities. The substitution research is not tied to any single communications system, present or projected, but is focused on the potential impacts that will develop from the uses of a wide range of communications systems. Research starting from the direction of impacts rather than particular technologies is almost certain to have more widespread applicability across various societal sectors, and in some cases, between societies themselves. The material in this paper is designed to illustrate some of the types of impacts that future travel—communications substitution may have in the next decade.

The potential of future communications-based systems to stimulate some form of substitution for "travel is a frequent subject of discussions of the future environment. Most forecasts seem to lie at each end of a spectrum of possible analyses. At one end there are broad generalized scenarios optimistically postulating many forms of substitution of local and intercity travel through the use of a host of computer-communications services. The links between today and the future are not usually detailed and we are left with considerable uncertainty as to how this future communications-based society evolved. The economic, social, and political benefits or potential negative impacts of this substitution process are also not examined in any detail. At the other extreme there are very specific studies of how specific technologies may augment the substitution process for individuals working at certain institutions with defined travel patterns. Between these two poles there is a considerable knowledge and research gap, Several projects underway at Bell Canada and in other institutions are designed to help till this knowledge gap. While many of the activities described here are Canadian or American, the author recognizes that parallel activities are also underway in Europe and Japan.

The question of substitution may be regarded as generic in the case of a macro-analysis. However, our futures research and that of others has indicated that the subject should be examined on two levels of substitution: inter-urban and intra-urban. inter-urban substitution refers to the process of replacing certain types of intercity travel with communications and computer-based services. This travel is usually that of businessmen, government, officials, or educators for defined occupational purposes. Intra-urban substitution refers to the process of replacing a wide variety of activities within an urban area with a large number of electronic services. These forecasts usually include replacing daily commuting to work with "electronic offices" in the home or in neighborhood work centers. Electronic education, security, banking, shopping, voting, and consumer information retrieval services are also envisioned within the urban area in order to reduce the need to travel for many routine nativities. Much of the research and speculation in this area is found in the "wired city" or interactive broadband systems literature.

The term, substitution, is used here as a shorthand expression that refers to very complex, mostly unknown (to date), relationships between the transportation and communications sectors of our society. This relationship is not new, of course, as these two sectors have been intertwined in a maze of relationships since the development of postal, telegraph, and telephone services. Research on the impacts of these old communications services upon personal travel has been extremely limited to date. The simultaneous rapid growth in the use of modern communications and transportations systems during the last few decades in North America has masked the development of interrelationships between these two sectors. Studies have indicated that those who travel a great deal also use communications systems frequently. Thus, existing communications and transportation systems appear to be mutually reinforcing. However, many argue that the rapid proliferation of new communications technologies when combined with the current crises, congestion, and negative **side-effects of many transportations systems, will lead to a new era of substitution.**

The phrase substitution processes should not be interpreted too narrowly in terms of face-to-face personal contacts. While certain existing face-to-face contacts may be replaced in the future with new technologies, *new* forms of communications systems may create the ability to undertake activities that are impossible today with face-to-face contacts or existing technologies. Thus, substitution processes may, in fact, serve latent needs that have not been served up to now.

SUBSTITUTION: WILL IT HAPPEN?

An adequate analysis of the intercity substitution question must examine the fundamental reasons why people travel. There are obvious stated occupational reasons for many travel activities, However, there are a host of unstated social and personal factors at work when travel decisions are being made. An understanding of the travel-communications substitution issue requires research into these behavioral factors that would also underlie any future decisions on substitution. The other key variable involved in determining whether or not substitution will occur in the future is the financial cost-benefit trade-offs that must be determined between the costs of travel and the proposed communications substitute. This section of the paper considers both these variables on an inter-urban and intra-urban basis.

INTER-URBAN SUBSTITUTION

BEHAVIORAL ANALYSIS

The BPG has undertaken an analysis of these issues. This survey research was concerned with business travel in Canada between the cities of Montreal, Toronto, Ottawa, and Quebec City. Business travelers between these cities utilizing air, rail, auto, or bus modes of transportation were given a questionnaire to obtain the types of information shown below:

(a) Basic trip statistics;
(b) Purpose(s) of meeting(s) ;
(c) Information carried to or acquired at meetings;
(d) Reasons for not substituting existing communications media for this trip;
(e) Indirect personal activities associated with the business trip;
(f) An assessment of the most satisfactory and unsatisfactory aspects of the current trip;

(g) The Potential of various future communications capabilities to replace the type of trip the traveller is on currently; and

(h) Organizational, personal, and statistical data on the individual respondents.

The questionnaire was given to 30,000 business travelers during October 1978. Approximately 9000 usable replies were received, These permitted detailed sub-analysis of the substitution question by mode of transportation, particular inter-city corridor, organizational characteristics of the traveller's employer, executive level, ethnic group, and potential substitute capabilities. The response to the survey was a much higher level of returns than expected. This in itself may indicate that interest in the substitution question is becoming widespread among travelers.

The data from the survey was shared with the participating common carriers and government agencies. This information will also be traded with individuals and groups who are working on similar or related issues in outside futures research groups. The survey tested a series of hypotheses that were grouped into five categories: the communications situation; trip characteristics; idiosyncratic variables; role of the traveller: and telecommunications capabilities of the alternatives. The hypotheses were developed after an extensive search of the literature and research into communications behavior patterns. In many cases, the hypothesis were developed by other researchers after smaller surveys of sub-groups of travelers or through laboratory experiments with various test groups, The questionnaire was designed with the assistance of a consulting behavioral scientist in order to assure that the responses would help the BPG obtain useful data on the various hypotheses.

TEE HYPOTHESES WERE:

COMMUNICATIONS SITUATION

(u) There are **situational and behavioral variables associated with the particular form of communication that is to take place which predispose individuals to meet fact-to-face by traveling rather than to communicate over or through an artificial medium.**

(b) As the complexity of the communication task increases, the greater Is the perceived felt need for travel. Such predispositions occur at a significant level in bargaining, conflict resolution, and authority relation situations.

(c) Personal familiarity is negatively related to the propensity to substitute in situations that require (or are perceived by the actors to require) building or maintaining friendly relations, persuasion, assessments of others' reactions. or security.

(d) Routinized interaction activities have a lower trip threshold and a greater propensity for substitution than more complex non-routine interactions.

(e) The propensity to substitute varies according to the purpose of the trip.

(f) The propensity to substitute telecommunications for travel increases after a certain threshold of trip making is reached: the threshold varies depending upon the purpose of the interaction.

TRAVEL

(a) **Trips that involve the personal** transportation of materials, or for having material or equipment serviced or handled are negatively associated with the propensity to substitute.

(b) There is a positive relationship between the duration or number of activities engaged in on the business trip and the propensity to substitute.

(c) There is a negative relationship between the number of non-business activities associated with the business trip and the propensity to substitute,

IDIOSYNCRATIC

(a) There is a negative relationship between how business travelers feel about their general travel activities and **the** propensity to substitute.

BOLE

(a) There is a negative relationship between an individual's position in the business hierarchy and the propensity to substitute.

Telecommunications CAPABILITIES

(a) There is a **positive relationship between the traveller's** perception of the **utility of telecommunication alternatives to business travel, and the propensity to substitute.**

An overview analysis of the survey results indicate several interesting findings. Presentation of these comments should be prefaced with the reminder that these questionnaires were distributed before the Arab-Israeli war and its subsequent impact on energy supplies, travel convenience, and public consciousness regarding the negative societal implications of transportation systems. The overall results of the **sample indicated that** 20% of the **business travelers would have substituted the existing trip they were on, if appropriate communications substitutes had been available. This finding is not offered at this time as an indicator of the overall average potential for substitution but it appears to be a representative look at the short trip, commuter travel often experienced on the travel corridors studied.**

Factors that do not appear to influence the substitution decision include:

The travel corridor;
The mode of travel;
Whether going out on a **trip** or **returning from** one;
The number of associates with whom the businessman is traveling; and
The number of positive aspects perceived in the current trip.

The factors that do influence the substitution decision significantly include:

Those having shorter trips want to substitute more;
Those having fewer activities per trip want to substitute more;
Those who perceive more negative aspects of travel want to substitute more; and
Those engaging in more non-business activities per trip want to substitute less.

While the survey results revealed the above trends or tendencies, the correlations were generally much weaker than would have been expected, considering the fact that the original hypotheses were based mainly on earlier research. The strongest correlation was found with the telecommunications variables. Those respondents who perceived electronic alternatives favorably were more inclined to want to substitute future travel than those who felt that electronic telecommunications was too impersonal. The survey results also indicated that individuals from different types of organizations do differ in their propensity to substitute. Representatives from educational institutions were the most likely to substitute while representatives of non-technical manufacturing, finance, and insurance-related industries were the least likely to substitute. However, all of these results were representatives of tendencies rather than clearly defined profiles of non-substituters versus substitutes.

An overview of some of the results of the Bell survey took these factors into account when it concluded: "While 20 percent of the travelers surveyed indicated that they would substitute their current trip, the present study offers little support for hypotheses concerning replacement of travel by telecommunications. For the most part, the directions of the relationships postulated stand up **but the weakness of the correlation** coefficients **indicate that the variables** are of **little consequence** in distinguishing explanatory differences between those who would and those who would not replace their present trip. The lack of explanatory results suggests that the decision to substitute may be an idiosyncratic one which the variables included in this study did not tap." [8]

Thus, we have determined that there is a significant proportion of the business traveling public that would like to substitute certain travel activities with telecommunications but we have not identified a homogeneous model of the "typical" substitute.

COST-BENEFIT ANALYSIS

This form of behavioral research helps determine if people are willing to substitute in a "free-decision" environment. Often this is not a relevant factor in governmental, business, and educational institutions. Telecommunications systems that meet cost-benefit criteria definitely are most easily acceptable to

[8] James H. Kollen and John Garwood, "The Replacement of Travel By Telecommunications". 18th International Congress of Applied Psychology, Montreal, Quebec, July 30, 1974, pp. 26-7.

managers. Various studies have shown that audio and augmented audio teleconferencing systems usually turn out to be cheaper than travel for defined trip patterns. The reverse is almost always true for video based systems. All of these calculations involve an assumption of the cost of the time of the traveller (ie. it costs "x" dollars per hour for an employee whether he is traveling or in the office; hence, travel time saved equals dollars saved). The problem with these forms of calculations is that the institution has to spend more money in telecommunications systems in order to optimize the existing expenditures in salary charges. Illogical or not, many managers would rather have employees underutilized rather than spend more money to optimize a "sunk" cost, namely salary. If this attitude can be overcome then many non-video teleconferencing systems can result in net savings for the using organization.

One operational instance of detailed cost-benefit analysis is the experience of National Aeronautics and Space Administration (NASA) during the Apollo program. A series of teleconference networks were created, ranging from audio teleconferencing through to high speed facsimile (50 kilobits per second). These networks were used to replace certain types of travel during the course of the program. A series of analyses using various assumption patterns, indicated that the use of the networks saved from $1.4 to $4.1 million per year. An examination of travel costs before and after the introduction of the teleconferencing systems indicated that the average travel cost per professional assigned to the Apollo program dropped from $860 per year to $650 per year. These latter figures ignore the costs of time spent in travel whereas the earlier calculations assume an allocated cost of salary against travel. The study also noted that the use of teleconferencing resulted in many informal contacts and faster decisionmaking than could occur if travel had been the main form of long-haul interaction between the various groups involved? No attempts have yet been made to try and quantify these types of factors in a cost-benefit analysis. However, it is interesting to note that a rigorous application of cost-benefit analysis in the major institutional environment can result in considerable substitution of travel through the use of telecommunications.

INTRA-URBAN SUBSTITUTION

BEHAVIORAL ANALYSIS

The question of intra-urban substitution involves a different group of travellers and different behavioral issues. The type of substitution that is often discussed here involves the use of various "wired city" services. The area most analogous to the material reviewed above is "telecommuting". One of most extensive examination in this field is a recent study at the University of Southern California (USC).

The USC study examined two types of telecommuting in some detail. One part of the research was an examination of the attitudes of the user populations of interactive television systems used at USC and Stanford University. These systems were designed mainly to serve working adults who are studying towards advanced degrees. The alternative to physically attending the courses is to use the interactive TV system. Briefly, these systems are as follows:

The USC IITV [Interactive Instructional Television System], established in 1972, is designed primarily to serve professionals in engineering, aerospace, and information sciences who wish to take graduate level courses. These students are generally in mid-career and usually are employed fulltime by industries located from 10 to 30 miles from campus. Before installation of the IITV systems, these students commuted to the USC campus either in the evening or on a released-time basis during the day.

The IITV system transmits live lectures to ten regional centers from the studio at USC. Eight of these centers are located at major companies in the Los Angeles metropolitan area; two sites service clusters of companies. Regular academic courses are offered, both credit and noncredit, graduate and undergraduate. Since the program started, and average of 40 courses per semester have been offered by USC over the IITV network. The system includes talkback capability provided by FM radio transmitters at the remote sites. A daily courier service delivers and picks up homework, exams and other class work.'*

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* Samuel W. Fordyce, "NASA Experience in Telecommunications as a Substitute for Transportation," NASA Memo, April 19

10 Jack M. Nines, Frederic R. Carlson, Paul Gray, Gerhard Hanneman, Telecommunications-Transportation Tradeoffs, University of Southern California, December 1974, pp. 111–2.

The users of these systems pay the regular course charges plus surcharges for the right to telecommute. The corporations pay for the costs of the television classrooms. The USC study team felt that these two systems represented real cases of travel-communications substitution and conducted surveys to determine the users attitudes towards the substitution. The following four conclusions were drawn from the study.

"(l) Instructional television as a telecommunications substitute for transportation, offers the IITV user a substantial savings in time and travel. The director of the IITV system at USC, Dr. Jack Munushian, estimated that in the 1974-1975 academic year, the USC IITV system would save 250,000 commuter miles.

(2) One of the major motivations for participation, is a willingness on the part of the participant to complete or expand his or her educational training; given this motivation, the convenience and ease of the IITV system play a major part in the decision to participate. A corollary to this conclusion is that IITV students tend to feel that the availability of the system resulted in their taking a more aggressive attitude toward continuing their education.

(3) Users of an IITV system show greater affinity over time, indicating that familiarity with the system can favorably affect attitudes toward the system.

(4) Over 60 percent of the participants perceived IITV as being as effective as in-classroom educations (with Standford students showing a slight decrease in this assessment over time; comparison of grades and performance ratings by the instructors indicated essentially identical academic achievement for participants in the two modes (IITV and in-classroom). This response indicated that no appreciable (or at least quantifiable) loss in effectiveness was occurring as a result of using the IITV system." [11]

COST-BENEFIT ANALYSIS

It is interesting to note that the cost-benefit equations on both the inter and intra-urban trade-offs turn on the issue of valuing travel-time, whether this is allocated salary-time for institutional travelers or valued personal time for urban commuters. This leads to the conclusion that more than personal attitudes and accrued cost-savings to individuals and institutions will be required to lead to significant new levels of substitution in the shorter term. The energy issue is one example of an external force that will very likely cause a much closer examination of the substitution question than if it was left to free-will and normal market forces,

The USC study went on to examine the telecommuting question in the business environment. The Western regional office of a major national insurance company was examined in detail as a potential candidate for decentralization through the use of remote work centers and telecommunications support systems. This company had a central downtown location in Los Angeles and was examining various forms of decentralization, mainly as a result of high labor turnover at the clerical level. The corporate goal was to tap into new labor markets in the suburbs as well as eliminate the perceived disadvantages of long commute patterns for employees in those areas. Thus, this was a case where clerical rather than management or professional workers were regarded as a target for dispersion through the use of telecommunications. The USC team felt that this was a good case example as the company was one in the "information industry" where the substitution possibilities are expected to emerge first in the future.

The USC study determined that 15 remote work-centers connected with a computer and communications network would enable the insurance company to conduct its business on a dispersed basis. It went on to conduct a detailed cost-benefit analysis for both the company and the employees. The company saved costs in staff turnover and training, through reduced staff, lower salaries for clerical employees (a premium had to be paid to attract staff in the central location), elimination of a free lunch program, and income obtained from leasing the old headquarters site. Increased costs associated from the proposed system were in new building charges in the remote work centers, computer and communications costs, administrative and travel charges, and the floss of a special tax benefit given to insurance companies with one central office. The net savings to the company based on two different system configurations

[11] Ibid.. pp. 116--7.

were $4.1–$4.2 million annually. Thus, there were distinct cost incentives for the company to adopt the electronic work-center concept.

The cost-benefit calculation for the employees is not so straightforward. They lose monetary benefits in the form of the free lunches and salary premiums paid for working downtown. The cost savings for the employee revolve around saved travel-time and saved travel-costs. The USC calculations showed that any employee commuting more than seven miles per trip would save money. Since the average employee trip is 10.7 miles per trip, the average employee will save. However, ignoring problems of the "non-average" employee, one key assumption is that the employee values his time on a monetary basis. Time saved must be equated to dollars saved or the employee would result in a net dollar loss. This is not an area of certainty, especially with clerical employees versus professional employees such as those studied in the IITV survey. Generally, we can assume that an educational task would be required to induce old employees to want to try out this system. New employees in the suburbs would not present the same problem, and in fact the insurance company has operated non-electronic suburban work-centers for some time with a lower salary for clerical staff. This is certainly an area that will only be settled through the actual electronic decentralization of an existing operation.

Energy and Environmental Issues

INTRODUCTION

There are a host of environmental and energy issues related to travel and transportation systems. These have become increasingly important in public and private policy determination in the past decade. One forecast is that these factors may lead governments to promote or encourage communicating rather than traveling in the future. This could he through a wide variety of administrative mechanisms, including ones that may alter the economic cost-benefit ratio in favor of communications alternatives.

The environmental costs associated with transportation systems have become identified in considerable detail in the past decade. Current research is expanding information on these issues at a rapid pace. The environmental considerations associated with communications systems are virtually unknown, although recent interest has been expressed on the subject. Analysis that has been undertaken to date, leads us to believe that these costs are far lower on a per capita user basis than those for transportation systems.

Any comprehensive analysis of the environmental costs associated with travel and communications systems must go beyond an examination of operational costs of visible structures. The costs of construction of the physical plant required to provide these services should also be included. The environmental costs associated with maintaining the required infrastructures are required as well.

The phrase, environmental costs, has been used to refer to a wide variety of issues. The list be;pw is not exclusive, but it gives an indication of the types of environmental costs that are associated with the use of transportation and communications systems. These factors will have to be added to the economic and behavioral ones in order to provide an adequate analysis of the overall question of inter-urban and intra-urban substitution.

(a) Energy consumption of transportation or communications systems (increasingly important with the North American and European energy crisis).

(b) Energy consumption required to construct. operate, and maintain the manufacturing plant, and industry infrastructures for both sectors.

(c) Resource consumption for construction, operation. and maintenance of the required infrastructures.

(d) Pollution factors associated with the two industries. e.g. air, water, radiation, noise, thermal, and visual pollution.

(e) Damage to ecological systems.

ENERGY IMPACTS OF TRAVEL-COMMUNICATIONS SUBSTITUTION

As noted above, the energy implications of transportation systems are relatively well-known, The BPG analysis of the Canadian situation follows. It should be noted that a similar picture is found in the United States and much of the analysis would likely apply there as well.

The basic findings of our research indicate that the transportation sector of the economy accounts for 24 percent of the total energy consumed in Canada.

The passenger sector accounts for 60 percent of that energy consumption. Over 90 percent of all Canadian passenger-miles are accounted for by motor vehicle and air transport. Both of these forms of transportation are very energy inefficient. The importance of examining the business sector of passenger travel, as in the business planning survey, is shown by the fact that ***25*** **percent of all passenger travel is for business purposes (60 percent of all air travel is for business reasons). The influence of the transportation sector on total national** energy consumption levels indicates the possibilities for energy conservation through reduction of some forms of travel by communications substitution.

MACRO TRADE-OFFS

The task ahead is to identify the energy impacts of communications systems use. Research interest in this area has been growing rapidly. The energy crisis has led to many comments in the general and specialized press on the potential for some form of energy conservation through travel-communications substitution. Peter Goldmark, former President of CBS (Columbia Broadcasting System) labs, recently stated that if we "eliminated commuting over 10 miles, I have calculated that we could save half our current consumption of gasoline while generating only negligible amounts of pollution." [12] He also goes on to argue that creating a "new rural society" (use of the technologies described above to reduce business travel and commuting to work) would reduce the need for expanding large cities and would also reduce the energy required to support their centralized infrastructures-air conditioning, heating, lighting, elevators, etc. Goldmark's calculations, and those of all of the research in this field currently, are rough but they indicate the order of magnitude of the potential savings.

MICRO TRADE-OFFS

These overview calculations give a perceived perspective of the global implications of large scale travel-communications substitution. Several studies have tried to examine this from the opposite perspective; the impact of substitution for specific trips using defined technologies. Similar research has been conducted by the BPG and by the Communications Studies Group (CSG) of University College London and the London School of Economics in conjunction with their work with the U.K. post office.

The approach is to calculate the energy consumed in particular journeys using various forms of transportation. This requires estimates of the number of people traveling to a meeting which is a key variable for the transportation-energy consumption calculations. One of the difficulties in this form of estimate is that the number of people at one location for a teleconference is not a cost or energy consumption variable. The incremental cost of adding people on to an audio or video teleconference is virtually zero. Hence more people can attend a teleconference cheaper than in person. On the other hand, the length of a meeting without a reasonable period (one day) is a key variable for the energy consumption of telecommunications alternatives, and a fixed cost item for ***trans***portation systems. Another key variable in the telecommunications side of the equation is an assumption on the source of electricity for operation of the system, Electricity derived from hydro dams has a much more efficient conversion ratio **(85** percent) between primary and secondary energy (the ratio of the raw energy available at the source compared to the energy actually obtained for end usage) then say coal-oil ***(35*** percent,) or nuclear (30 percent) sources. This is particularly important in the Canadian situation since some provinces are highly **de**pendant on coal-oil and nuclear sources (Ontario) while others have large supplies of hydro power (Quebec).

The result of these types of calculators result in trade-off curves for various city pairs using defined transportation and telecommunications systems. Figures 3 and 4 illustrate the results of the BPG and CSG work respectively. This form of micro-analysis can be built back up to national estimates of macro-savings. The two groups have found in independent studies for Canada and the U.K., that approximately 2 percent of national energy consumption could be saved through the reduction of a moderate amount of business intercity travel. This does not include infrastructure savings or the reduction of intra-urban transportation. Details of the analyses by both Groups can be found in the referenced studies,

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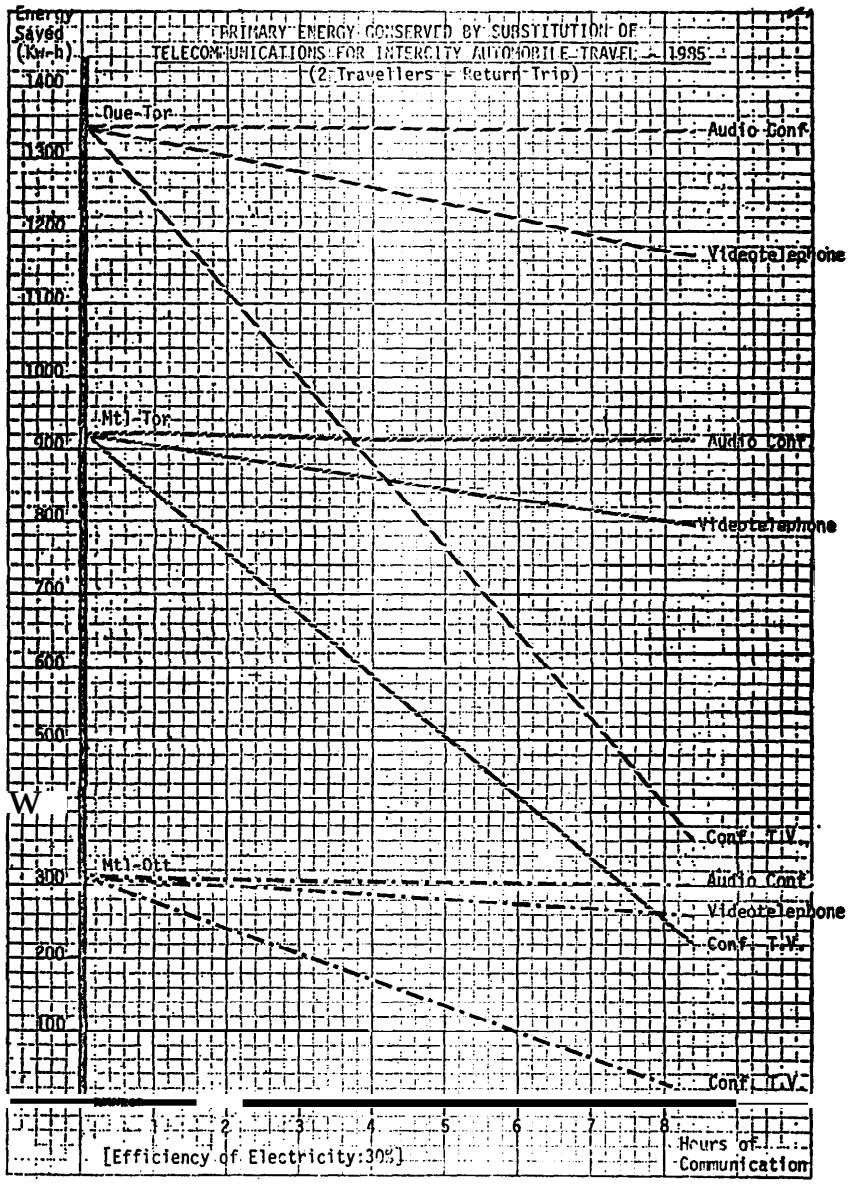
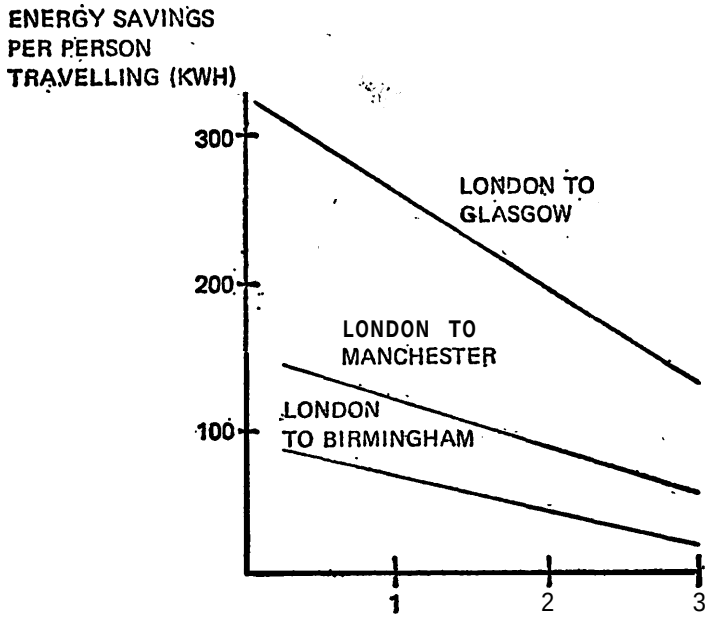
12 Peter C. Goldmark. "A Rural Approach to Saving Energy : Technology Could Help Ease Urban Congestion", New York Times, NOV. 12, 1973, p. 12.


Energy Saved (Kw-h)
PRIMARY ENERGY CONSERVED BY SUBSTITUTION OF TELECOMMUNICATIONS FOR INTERCITY AUTOMOBILE TRAVEL - 1995
(2 Travellers - Return Trip)
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
Que-Tor
Audio Conf
Videotelephone
Mtl-Tor
Audio Conf
Videotelephone
Conf. T.V.
Mtl-Ott
Audio Conf
Videotelephone
Conf. T.V.
Conf. T.V.
W
1
2
3
4
5
6
7
8
Hours of Communication
[Efficiency of Electricity:30%]

ENERGY SAVINGS OF CONFRAVISION OVER RAIL TRAVEL (PER PERSON) FOR THREE INTER-CITY ROUTES



SOURCE: PYE, ET. AL., TRAVEL OR TELECOMMUNICATE? THE ENERGY CONSIDERATIONS. P. 9.

Similar calculations have been made by Dickerson and Bowers in their preliminary TA of the video telephone conducted at Cornell University.[13] Dickson calculated that an 8-hour meeting between Los Angeles and New York was 8 times as energy efficient as a return personal trip using a Boeing 747.

While energy issues are important, there are other environmental issues that should be considered in the travel-communications equation. Pollution is certainly one of the factors. Van Vleck points out that the transportation sector

[13] Edward M. Dickson and Raymond Bowers, The Video Telephone: A New Era in Telecommunications, Cornell University, Ithaca, N.Y., June 1973, p. 144.

produces 75 percent of the carbon monoxide. 56 percent of the hydrocarbons, and 52 percent of the nitrogen oxide pollutants.[14] These side-effects of travel must be shared by all in our society, not only those who travel.

The question of resource consumption has also become more widely understood as planners and decision makers become more aware that we have a finite stock of 'non-renewable resources and that the demand is outstripping the replacement of renewable resources. The transportation sector is an important consumer of many of these resource elements. Recycling will have to become more prevalent in the transportation industry in order to preserve material resources. Substitution is another means of conserving resource depletion, Again, we do not yet have material consumption patterns available for telecommunications, but we do have some idea of the facts for the transportation sector. The U.S. transportation industry consumes 75 percent of the nation's rubber, 53 percent of its lead, 40 percent of its zinc, 29 percent of its steel, and 19 percent of its copper.[15] Further research is required to determine the communications industry's consumption patterns and the elasticity of the material trade-offs between the transportation and telecommunications industries.

The energy, pollution, and material elements of the substitution equation are certainly incomplete at this time. We can obtain an idea of the relative impact of various trade-offs through the preparation of scenarios assuming levels of **substitution. This is only one step towards a greater understanding of this issue. However, it is certainly a move away from merely assuming that these trade-offs will favor the communications half of the substitution issue.**

Social and Policy Issues

The material reviewed to date has revealed that the substitution issue has many dimensions. This last brief section overviews some of the other questions and issues that will have to be examined in any comprehensive examination of travel-communications substitution.

POTENTIAL NEGATIVE IMPACTS

No development is without its negative drawbacks. Those of us examining the substitution question may tend to overlook some of these potential problems. Several of these are listed below.

PRIVACY

The adoption of substitution as a significant conscious choice in many sectors of society will bring us face-to-face with many of the privacy and security issues that have been troubling many observers for the past decade. Dependence on computer and communications services for so much of our social interaction is certain to bring about periodic lapses in personal and institutional privacy. These issues have been discussed extensively elsewhere and this paper will go no further than to indicate that they certainly have relevance to the substitution issue.

LOSS OF INTERPERSONAL INTERACTION

Many social scientists and thoughtful observers have pointed out that work activities have a very high level of social interaction content, People need to interact with people on a purely social level and work settings create the ability for this to happen. Reduction of intercity travel may cut back the range of interpersonal experiences that individuals have access to during their travel. Reduction of commuting patterns through the use of remote work-centers or home work-centers would also have a severe impact on interperson interaction. If remote work-centers were common public utilities rather than dedicated to specific institutions (a likely scenario in order to reduce the cost overhead of these institutions) then the interpersonal bonds that develop may be based upon friendships of people who happen to use the same work-centered rather than work for the same employer. This could have significant impact on job mobility patterns and employee loyalty. These social factors lead this author to forecast that remote work-centers will only be used two or three days a week with the other weekdays being used to go into the central business district for meetings and social contacts with other people in the institution.

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[14] F. M. Van Vleck, "Substituting Telecommunications for Travel: Feasible or Desirable, IEEE National Telecommunications Conference, San Diego, California, p. 5.
[15] Ibid., p. 6.

DISRUPTION OF HOME LIFE

The above forecast is strengthened when the potential disruptions of home life are considered. Having the working husband and perhaps working wife, plus children, pets, etc., in the same environment continuously would likely be more of a strain than most people could survive. Working at home occurs now with the use of portable terminals, and its popularity will climb rapidly in the next decade. However, the home life problems will limit this to being a sporadic activity rather than a regular occurrence. The remote work-center is the more likely means of reducing the tensions that would follow a permanent shift from the office to the home.

SECTOR UNEMPLOYMENT

Gradual substitution is the most likely scenario for the future. However, if significant shifts occur in institutional or individual attitudes, energy availability, environmental awareness, or the cost-bene!it trade-offs between travel and telecommunications then we could expect to see rises in the unemployment levels in the transportation sector. This is not a minor factor. The transportation unions are some of the strongest in North America and have a long history of righting (successfully) technological or policy advances that they perceive as having a negative impact on their members. The telecommunications industry is far more automated than the transportation industry, and a corresponding growth in employment in the former field would not likely follow cutbacks or reduce growth in transportation. The transportation industry also has a successful history of lobbying with the political sector of our society and we might expect to see attempts to make substitution a political issue if the industry began to see it as a significant threat to present or future business growth.

DISRUPTION POTENTIAL

Just as significant reliance on telecommunications creates a privacy problem, it also raises potential dangers of massive failure, sabotage, strike shut-downs, and breakdowns due to natural disasters. Systems will have to be designed in a fashion similar to the existing telephone network. This means considerable redundancy, distributed intelligence, human back-up and control override capabilities, and rapid recovery ability. There must also be the capability to eliminate the cascading disaster possibility that has caused major problems in the electrical industry. The potential dangers here certainly weigh heavily against a very centralized system.

ACCESS RIGHTS

The question of who will be allowed or will be able to afford access to the technology that can make substitution possible has troubled many observers. The phrase "information rich and information poor" has come to symbolize this concern. It can be argued that substitution, especially for local transportation, will only result in the creation of further ghettos. The poor will be even more cut-off from the affluent who will *be* able to work in electronic isolation. If the urban substitution process was carried to its ultimate conclusion, large cities would have their economic structures cut out from underneath them. The commuters would cease to be a source of tax revenue and hence cut out a significant slice of city revenues. On the other hand, many clerical and support jobs might move to the electronic work centers where the poor could not afford to commute, thus creating employment dislocations. The support industries of the city (restaurants. shops. service trades, etc.) would lose significant markets. This negative scenario postulates a drop in the revenue base of the city along with a great increase in the need for social support systems as the underprivileged see their employment opportunities shrink. The scenario is quite likely to never occur. As noted above, there are many social and other reasons to expect employees to want to go to the central offices several days a week. **In** addition, we could expect to see government and business lenders take positive actions to avoid most of the severe impacts postulated above before events got out **of** hand. Nevertheless, the question of access to substitution systems and the social-political impact that would develop from their widespread use must not be treated lightly as travel-communications research and policies are developed.

There are certainly other potential negative implications of travel-communications substitution. This short list is merely presented to indicate the range of possibilities and the agenda for future substitution research.

POLICY QUESTIONS

The whole topic of substitution also raises a series of policy questions that have only been alluded to up to this point. Several of these issues are reviewed below.

ENERGY POLICIES

Long- and short-term energy supply issues, compounded with the resource and pollution questions, may lead governments to regard substitution as a partial solution to these problems. If this occurs, governments are going to move from a passive interest in the potential of substitution in a few telecommunications oriented agencies and departments, to an active interest at the highest policy levels. One of the questions that will arise immediately is the question of relative subsidies between the industries.

SUBSIDY POLICIES

The transportation sector of the economy has traditionally been directly and indirectly (e.g. government-financed research) subsidized. Ship, rail, auto, and air transport have been heavily subsidized for capital (e.g. land grants), operating costs or losses (e.g. on non-profitable routes where it is socially desirable to maintain service), and in infrastructure investment (e.g. airports, highways, etc.). On the other hand, the telecommunications field has been less heavily subsidized and more regulated than the transportation field. This historical trend has occurred for a number of reasons:

> communications deals intimately with fundamental information freedoms, the right to privacy, etc. Thus the government has restricted itself to primarily regulatory and policy-making roles in this area. Another possible reason is that electrical communications has been, for the most part, highly profitable to the private sector from the beginning, when it has not been, as in telegraphy in late years, and to some extent in UHF television, the regulatory agencies have acted strongly to support these media to the extent that regulatory actions can help." [16]

The question of travel-communications substitution raises the subsidization issue from a new perspective. If the social benefits of a substitution are strongly positive, then existing patterns of subsidy may be socially counterproductive. Either the transportation subsidies should be reduced or telecommunications alternatives to travel should be subsidized in some fashion. This whole question is a likely target for a massive study in itself. The issues are much more complex than mentioned here. However, the subsidy issue will have to be examined in both government and private industry before the substitution puzzle can be completed. These studies will probably lead to further questions on the process of regulation itself.

REGULATION

The question of regulation of the transportation and telecommunications industries flows from some of the above considerations. A substitution policy cannot be formed within a single government regulatory body. Telecommunications and transportation are regulated in Canada and the U.S. by many different agencies or branches of large regulatory agencies. A substitution policy cuts across the mandate of these various groups and frictions can be expected if substitution becomes an important policy issue. Of course, it may not become an important issue for the traditional transportation and telecommunications regulatory bodies since it may be regarded as lying in a no-man's land between them. However, a likely scenario would be for a new organization, such as an energy or an environmental agency to provide the substitution focus that would then bring about interest from all of the parties. It seems likely that we could not expect to see rapid solutions to some of the regulatory issues until this institutional process sorts itself out.

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16 Ibid., p. 9.

INTERIM APPROACHES TO POLICY

The term, interim, is used to indicate that government actions are still possible, and probably required during the regulatory shakedown period postulated above. Policies can be refined much easier when there are more hard data and information available that demonstrate the existence of viable technological, economic, and socially acceptable patterns of travel-communications substitutions. These data will only emerge through a continuation of the type of research referred to above, only in much greater depth than to date. Research into all of the aspects of substitution discussed in this paper is certainly needed. Government agencies from both the transportation and telecommunications sectors, as well as in third party agencies (e.g. energy) should conduct and sponsor research and experimentation into substitution. The results of this research will certainly indicate whether or not the policy issues are important enough to risk the bureaucratic upheaval that some of the above policy shifts would generate.

CONTINUING RESEARCH

The material reviewed in the foregoing section on social and policy questions raised a number of important unanswered questions. In the introductory section it was noted that the substitution issue has been a subject of considerable interest for the BPG for the past 5 years. This interest continues and current activities are centered on some of the issues explored above.

The joint study with the Stanford Research Institute (SRI), the Business Planning Group (BPG), and the Communications Studies Group (CSG) of London is designed to answer many of these questions, especially those associated with the intra-urban area. This study, which is approximately 80 percent complete at this date, is an extensive examination of about 60 areas and their policy implications associated with intra-urban substitution under a variety of substitution scenarios. The BPG has filled in some of the gaps with its research and will participate in the data sharing with other members of the study team who have pieces of the puzzle. Thus, involvement with this TA study is a part of the BPG activities associated with a long-term and continuing TA of the substitution issue.

Another activity is a current project that is attempting to evaluate the key issues associated with working from the home and other remote locations. This study is assembling all of the relevant data from a number of research areas (the SPRITE study, the SRI/BPG/CSG study, teleconferencing research, and the BPG evaluation of the paperless office trial in the perspective Of working from home. This study will identify the key positive and negative issues associated with this aspect of substitution and will lead to corporate recommendations and, perhaps, further research into important unanswered questions.

Finally, the extensive evaluation of the Paperless Office trial referred to above in several places, is in itself a TA. The evaluation is being conducted with the cooperation of over a dozen U.S. government agencies and business firms and their users of NLS. This evaluation will result in the first detailed look at the widescale experimental use of a multi-organizational computer system that permits working at home, electronic mail, joint authorship of documents from remote locations, office management tasks, data base construction, and text editing-word processing.

A key part of this evaluation is the data being received from a detailed 28-page questionnaire that has been filled out by representatives from all the user groups (with the exception of the U.S. National Security Agency for obvious reasons). While sections of this questionnaire are oriented towards regular systems evaluation and human factors issues, significant data is being obtained which would be expected in a TA activity, Some of the impacts explored in this area are:

On the flexibility of working hours;
On the need to adapt to the system rather than vice-versa;
On accessibility of work to others;
On privacy;
On individual's professional images;
On face-to-face communications versus computer-mediated interaction;
On work styles;
On the use of normal mail systems;
On communications patterns with subordinates, peers, and superiors;

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On remote and working from the home; and
On managerial styles.

All of these continuing activities are a part **of the longer term pattern of an on-going evaluation of the various primary and secondary impacts associated with the substitution issue. This process will be referenced in the final section of the report in which the impacts of TA for Bell Canada and industry and government in general will be discussed.**

IMPACTS ON BELL CANADA

INTRODUCTION : THE GENERAL IMPACT

This report has **been oriented to this** point to projects, past experiences, and specific studies. In this section, a more subjective evaluation of the impact of TA on Bell Canada will be undertaken. This evaluation should be placed in the context of our own evaluation of TA and its future.

TA has been an activity that, to date, **has been associated with the conduct of specific studies that were of interest to various funding organizations. Most studies have been funded by neutral agencies such as the** U.S.-NSF that do not have decisionmaking roles. Most government and business firms which have funded or conducted TAs, have not touched upon especially controversial or key areas of concern to the parties concerned. The studies have also not **been directed toward helping resolve thorny decision questions of agencies-or firms. Many organizations have regarded their TAs as learning experiences with the process of assessment. These experiences have often been oriented toward learning about the methodologies that can be used to conduct assessments and what their various strengths and weaknesses are. TAs have also been directed toward broad question areas rather than very specific issues. All of the above statements are generalizations, of course, but they do serve as a very shorthand history of TA to date. As the studies in the previous section indicate, these comments also summarize the Bell Canada experience.**

The above statement is not intended to minimize the importance or honest effort that has been placed in the studies of Bell Canada and the other organizations. Bell Canada is committed as an organization to understanding the social impacts of its decisionmaking process. In February 1975, Bell Canada, in association with Datacap Ltd. organized a conference on Technology Assessment and The Limits to Growth. This conference was formally sponsored by the Ministry of State for Science and Technology and the International Society for Technology Assessment. Over 300 individuals from business, government and academia attended this Ottawa conference titled: Technology and Growth. J. C. Thackray, now President of Bell Canada, stated in his welcoming address to the conferees:

"There may be some of you who wonder why Bell Canada is so deeply involved in a conference of this nature. We're the supplier of the communications services that many of you use every day. Maybe at one time in the past that may have meant simply providing equipment. But not any more. For many years, we have been concerned with the effects that our business can have on the total environment, Not just the immediate and obvious effects, but the long term consequences, How do telecommunications affect the evolution of society?

It is our firm belief that technology must be the people's servant, not their master. In our research, our planning, and our on-going study of environmental affairs, our objective is to ensure that our services meet the needs of the public and that the side-effects of our actions are in the public interest." [17]

This understanding of the importance of TA is a clear indication of the impact that the Bell Canada experience with TA has had. To a significant extent, the Bell Canada experience with TA has been an educational one. At the senior management level, a significant measure of understanding the futurity and social impact of technology-based decisions has been gained. At the professional level, the business planners have gained a healthy understanding of the strengths and weakness of TA and the methodologies associated with the process.

A significant part of! this understanding is that it is the process itself, not the particular study that really counts. Important areas cannot be given the effort they require in a single, normally short timeframe study, that attempts to answer the important questions associated with the topic. The Bell Canada experience with travel communications substitutability, research indicates that a continuing research program into expanding areas of concern can identify a broad

[17] J.C.Thackray,Introduction to 'Conference, Technology and Growth proceedings, Business Planing Group, Bell Canada, June 1976.

range of impacts in considerable detail. The process of monitoring a field over a period of time helps identify the key impact areas. These can be given an in-depth examination rather than cursory treatment, in a study that tries to identify all possible impacts in a time- and resource-limited environment. Too many **TAs end up becoming catalogs of impacts rather than the definitive documents that their sponsors and assessors would like to see.**

The above comments reflect an assumption on the process of decisionmaking in many business and governmental organizations. Decisionmaking is often an incremental process. This can he, of course, very negative if environmental decisions are made that are regarded as minor but have long-term cumulative and harmful impacts. However, if TA processes parallel these incremental decision-making activities, combined with a good monitoring system, there is the potential for a very powerful form of TA. The process of incremental TA in a business or government mission agency can lead to a more serious understanding of the secondary impacts of various decision streams than "single shot" studies that attempt to do too much and end up accomplishing too little as a result of their over comprehensiveness, and the normal difficulties of accurate long term forecasting of any type, especially serially-ofiented forecasting. Thus, one of the important lessons learned in Bell Canada. is that an incremental approach to TA may be more important in business-oriented TA activities than large single effort studies that are oriented towards the relatively rare, one-time, major, irreversible decision. This is quite different from the type of decisions that are made in the political environment leading to bills being passed that may have a long-term impact and where the legislature may not revisit the field with new legislation for some time.

Another lesson learned with our TA and technological forecasting activities is that experience, even of a limited nature. with the developments in question can be of considerable value when compared to large amounts of paper speculation, no matter how sophisticated the methodology or how knowledgeable or prestigious the individuals who input to the process. Thus, an incremental **TA process can include the concept of field trials that generate experience with the technologies in question. This type of experience is social impact-oriented as opposed to merely gathering market or technical trial data.**

This experience and the concept of incremental TA with feedback from trials and ongoing monitoring activities is being applied in a current case. This is also a case of considerable importance to Bell Canada and is not an item of mere academic concern. The new service-technology is called "incasting" and it is an ideal target for the type of treatment described above.

INCASTING : APPLYING THE EXPERIENCE

"Incasting" is a form of instantaneous electronic polling that can be conducted using the regular telephone network without any interruption to the normal flow of telephone traffic. The prime motivation for this development has been the desire of the Canadian Broadcasting industry to have a form of interactive broadcasting with convenient and rapid feedback from the audience. With "incasting," home respondents would have a small two-function voting device called a Votaphone. There are two types of Votaphones that would be available. The first would be universally available to any home requesting one. The second would be used in **homes that are a part of a statistically-controlled random sampling of homes that could be used for scientific inferencing and extrapolation. The "incasting" operation has been described as follows:**

"During the proposed 10-second period of an interactive broadcast. the home audience is able to vote or respond by means of a specifically installed item of residential equipment called a Votaphone. The Votaphone itself is an extremely simple keyboard unit containing only two pushbuttons.

By voting in carefully prescribed sections of the lo-second response period, it is possible to vote in more than a simple binary yes-no format. For example, if the two pushbuttons are labelled + and —, they can he interpreted as meaning yes and no respectively in the interval 1 to 5 seconds, but be interpreted as, "Do not know," and "Do not like the question," 'if depressed in the interval **6 to** 10 seconds. Human factors studies show that the minimum sub-interval that should he considered useful is 2.5 seconds. **This permits choice of up to 8 ways of casting the single vote during a 10-second voting period, since the vote can be either positive or negative in one of four time-slots. "** [18]

[18] Peter Parkinson, "Incasting," proceedings of the Second Subscriber Loops and Services Symposium, London, U.K., May 1976 .p. 97.

The clients who would use "incasting" would probably be in the broadcasting field. They would purchase "incasting" time slots and integrate the questions into their broadcasts. The answers to the questions from the audiences (the universal or statistically inferential ones) would be delivered to the broadcasters in a matter of seconds. The users might fall into a number of categories. Public affairs broadcasting would take on a new dimension with instantaneous audience feedback. Advertising could change in the same way. Government, public interest groups, politicians et cetera, might use it to gauge public interest on various topics. The possibilities become wide indeed once the concept is grasped.

The concept of electronic polling (as opposed to voting in the political sense) has been discussed in the "wired city" and interactive cable television literature for some time. However, it has been regarded by many as mainly a theoretical possibility in the distant future when new communications infrastructures have developed. The essential difference with "incasting" is that it could be developed today, using the existing telecommunications structure, at a relatively low cost, and operate without damaging the existing telephone traffic. A technological and conceptual breakthrough (now patented in Canada and the United States) makes this possible.

Bell Canada is studying the possibility of having an "incasting" trial. The Canadian broadcasting industry is very keen to participate. Other interested parties such as the Canadian Radio-Television and Telecommunications Commission and Statistics Canada (both Federal Government agencies) are also very interested. The internal Bell Canada decision is being pursued along a number of paths that would be expected in any significant opportunity analysis. However, the social-political issues have been some of the most prominent since the project was undertaken.

It is clear that even though this is a polling system and not a voting one, that its use could have significant social-political impact. The internal debates at the highest levels of the corporation have often concentrated on these TA issues rather than the pure business interest or technology ones, These debates have been very intense and the TA process is being brought into play. A consulting political scientist has been exposed to the concept and has provided new insights into the potential impacts, Further seminars are planned with knowledgeable experts in relevant fields in order to map out the impact possibilities. The project manager for "incasting" has personally conducted the CAI-TA referred to above, and hence is more than casually aware of the TA processes that have to be brought to bear in a case such as this one. Finally, any decision to conduct an "incasting" trial will be matched with one to track the social impact aspects of the trial.

The "incasting" project is in mid-course and it is difficult to know how it will be resolved. There is not any corporate commitment to even conduct a trial at this time. However, as the "incasting" story unfolds, the process of corporate TA will be followed. As noted in the previous section, it is the author's conviction that the use of a TA process as a part of the on-going managerial process of decisionmaking is of far greater importance than single-shot studies. The use of a TA process throughout the "incasting" project will be far more significant than one study on the social implications of electronic polling.

Conclusions

Bell Canada and the BPG have been seriously committed to TA for the past four years. Similarly, the organization has been committed to some of the basic concepts for a much longer period of time. The experience with TA itself has been an evolutionary one. This experience has been educational at both the methodological-professional level and at the decisionmaking level. Our current view continues to support professional research activities where new information is required. However, we have come to recognise that TA is more valuable in the corporate environment when it is a normal part of the continuing decisionmaking and re-evaluation process than when it is only associated with one-time studies of particular topics. The material outlined in this document. particularly as it is related to the work in travel-communications substitution and to "incasting" is offered as concrete experience to support this philosophy.

APPENDIX I : TECHNOLOGY ASSESSMENT AND INDUSTRY

INTRODUCTION

TA has been a concern of governmental bodies for some time. The role of the industrial sector in **TA has** not been **discussed widely beyond the obvious nega-**

tive role of being a target for problem-oriented assessments. This short review will attempt to present a more positive role for the corporate sector.

industry's involvement in TA can occur as a result of several different types of pressures. These pressures for involvement can be grouped into three categories: (a) **defensive reactions; (b) positive pressures; and (e) corporate social responsibility. Each of these forces will be reviewed in turn.**

INDUSTRY AND ASSESSMENT

DEFENSIVE REACTIONS

Legal

The introduction and enforcement of environmental protection statutes have proved that institutions can be made legally responsible for the secondary consequences of their actions. One school of thought in technology **TA feels that prior assessment of the potential secondary impacts of major business decisions will become a legal requirement. Legal issues will also arise if TA becomes part of the adversary regulatory system used in many OECD nations. Hence, some corporations are starting to conduct TAs in anticipation of more formal requirements to do so,**

Potential Bias. The overwhelming interest in government-oriented TA when compared to the business contribution has led some people in industry to fear that all assessment work may have an anti-business bias. If this does not *occur* there is still a fear that the assessment activities will be too academic. When the legal question reviewed above is taken into account as well, business planners are led to believe that they must provide a contribution to TAs or this potential for bias could become a serious problem in the long term.

R & D Planning. TA is designed to be an anticipatory process A realistic analysis leads us to conclude that most of the introduction of new technologies in OECD countries still occur in the private sector. An understanding of the development and implementation process for technologies into society reveals that this is a complex process that begins with basic R & D planning. Inclusion of TA inputs to this system should begin at the earliest stages of technological research. It is unlikely that many businessmen would accept inputs from government assessments alone. Thus, industry's role in the R & D process is also creating pressures to conduct extensive assessments.

These initial pressures are negative in the sense that they indicate events are forcing industry to become part of the assessment movement rather than becoming contributors in a voluntary way. This is not the case, as there are positive forces at work that make TA a logical activity for corporations.

POSITIVE PRESSURES

CORPORATE LONG-TERM PLANNING

Many of the techniques that are used for TA are those used in long-term planning in business. Other useful techniques are found in market research and planning, econometric modeling, and statistical analysis. While there is a clear distinction between these forecasting techniques and a complete **TA, familiarity in industry with the use of these methodologies creates fertile ground for TA in business. The main thrust in TA is to extend the vision of business planners to secondary as well as primary impacts. This is an evolutionary, not revolutionary, step for planners in many of today's large business concerns.**

As **noted above, the development of strict environmental control statutes in many OECD countries has led to the requirement to prepare studies** showing the potential secondary impacts of introducing new technologies into the environment. The ***involvement*** of **corporations in sponsoring or directly preparing environmental impact statements has acquainted both corporate planners and business executives with the concepts and practice of examining secondary impacts in advance of taking actions. It is not difficult to move from examining environmental secondary impacts to reviewing the broader range of considerations involved with** TAs once the decision maker is familiar with environmental assessment.

COSTS

Experience in trial and actual TAs has indicated that they are often quite costly. Most of these studies have been conducted by outside groups not part of the decisionmaking agency. Outside assessments by consulting firms, uni-

versities, or government agencies appear to spend large portions of their resources in acquiring a data-base of information required to gain knowledge of the industry and technology that they are assessing. Cooperative research with industry in conducting assessments can help reduce the costs of assessments considerably, in some cases this may be an order of magnitude reduction. This scale of reduction is possible as industry often has the basic background data available in its files. The costs of reconstructing this data are often monumental, with no assurance that the reconstruction will be accurate. Preparation of assessments by industry or joint work with government, university **or consulting agencies in a cooperative non-hostile environment may help make TA a more cost effective process.**

CORPORATE SOCIAL RESPONSIBILITY

The discussion above has noted that there are negative or self-preservation reasons for corporate involvement in TA, and that there are also positive reasons for TA to become a natural evolution of business planning activities. There is an even stronger pressure for involvement than these factors; this is the growth of what has become termed "corporate social responsibility." While this is often regarded as mere rhetoric or good advertising fodder by non-business people, there is in fact a hard-core development here that is quite serious. This is not a universal factor across business or particular industries but it is a rapidly growing consideration in many corporations. This consideration in business makes TA a central activity of the future in corporations that are truly interested in the social impact of their decisions.

The author expects that this interest will develop first in industries that are currently under some form of government regulation. Regulated industries have experience in dealing with governments on a routine basis and are not quite as caught up in the standard government vs. business rhetoric that occurs elsewhere. The preparation of TAs in regulated industries and their reception by regulatory and other government agencies will act as a good model for future voluntary assessment activities in industry. Widespread failure in this arena would probably lead to a reduction of assessment activities on a voluntary, positive basis and result in a return to assessment work for the more negative reasons outlined above.

Most indicators show that TA and industry will have a productive relationship. However, this does not mean that there will not be problem areas with industrial assessment activities. Several of the most significant potential problems are reviewed below briefly.

POTENTIAL PROBLEM AREAS

CREDIBILITY

This is the most basic problem and should be faced realistically. Many **TAs sponsored or conducted by industrial groups will be regarded by many government and academic groups as tainted by their parentage. This view will be a sound one in some cases but will be unfair in many others. Objective, methodologically sound, well-conducted assessments should not be lost in the intellectual and political rhetoric. Industry has a valuable contribution to make in a TA and each individual study should be measured on its own merits.**

COST BURDEN

The costs of TA will certainly cause serious questions in industry. The costs of assessment involve more than the direct financial burden of conducting studies. Other costs include the financial and opportunity costs of lending experts to assessment teams outside of the parent organization. Costs also include the potential danger of the loss of proprietary information given to assessment teams who then publish their findings widely. All of these cost elements become important in national or international competitive environments where all of the competitors do not decide to conduct assessments.

IMPACT ON INNOVATION

One of the common statements of concern regarding **TA is that it will slow down the rate of innovation in industry and in the** economy generally. These concerns are genuine, especially in the increasingly competitive international economy. While the concept of growth for its own sake is rapidly becoming regarded

as questionable, even in some businesses, it is difficult to convince one company, industry, or nation to voluntarily slow down its own growth unless it is assured of some form of quid pro quo from its competitors. Organizations like the OECD will have an important role to play in assuring that these innovation impact considerations are resolved satisfactorily on an international scale.

SUMMARY

The inputs from TAs should be also added into the process of constant decision-making in industry. This can only occur if industry takes an active role in conducting its own assessments as well as utilizing the work of government and academic agencies. TA will have achieved its greatest success if assessment inputs are routinely used in decisionmaking rather than if they are only imposed by regulation on certain types of decisions. The problem areas reviewed above are important but on the balance business can be expected to play a valuable role in the movement for widespread use of TA recommendations. The author feels that the realities of modern economic life in the OECD nations demand that industrial assessment activities become widely accepted and encouraged. Industry makes many of the most important decisions today on technology adoption and will continue to do so in the future in Western economies. TA mechanisms that only examine the secondary impacts of these decisions after they start to emerge will be a limited success. Regulation as used in traditional regulatory bodies does not appear to be the best model for the future.

Appendix 2: Technological Imperatives In Telecommunications

Much of the interest in the question of substitutability has resulted from a recognition that new communications and computer technologies offer many capabilities that may reduce the utility value of personal travel when compared to these services. Promoters of specific technologies often claim that their innovations alone will reduce the need for travel. These claims are optimistic and perhaps unfounded when viewed in isolation. However, the combined capabilities of the various emerging technologies will certainly have an impact on the substitution issue. Several of these major thrusts in technology are reviewed below.

TWO-WAY BROADBAND SYSTEMS

Most of the literature in this field has been concerned with an expansion of the capabilities offered by co-axial cable currently **being used to deliver cable TV signals. These broadband channels can be converted to interactive use through the use of additional electronics to provide low-speed (audio grade) or broadband (video grade) return paths from the receiving location to the central distribution point (the "head end"). These return path capabilities can also be provided through the use of the regular telephone channel. The significance of these systems is that they create the ability to deliver "on demand" selective visual information over the broadband channels. These systems have the theoretical capability over time to add random switching so that each subscriber can call any other subscriber in a fashion similar to telephone calls today. These calls could be audio, audio-graphic, or audio-visual in nature. It is still questionable whether the providers of cable systems will invest the additional capital required to provide these types of capabilities. The recent difficulties in the cable TV industry have strengthened the view that widespread use of interactive television into the home is further off than many have predicted in the past few years.**

Two-way broadband systems could provide a certain amount of selective, private delivery of information to subscribers in residential areas leading to some forms of intra-urban substitution (where most systems are installed and will be installed for the next decade or so). These possibilities have led to a number of forecasts on the potential of working from home.

The availability of a host of consumer-oriented capabilities has been forecasted by those expecting the development of a "wired city" (a misnomer since most cities are already wired for power and telephone systems). These services include:

Remote shopping;
Remote banking;
Electronic security services;
Electronic education;

Electronic voting;
Consumer information retrieval systems; and
Remote medical systems.

As noted above in the introduction, the papers presented by other members of this panel discuss some of the implications of the use of these types of systems on business-oriented intra-urban travel. The use of these technologies could also lead to substitution of certain forms of non-business intra-urban travel. The BPG of Bell Canada has conducted a modified Delphi study of the potential acceptance of these types of services in the home. The results of this research are described elsewhere. This work is being continued currently with a detailed **TA of** the positive and negative secondary impacts that may result from the use of "wired city" services. The intra-urban substitution issue is one of the items that will be reviewed in this project. There are other technologies that are generating interest in the substitution thesis. One of these is video teleconferencing.

VISUAL TELECOMMUNICATIONS TECHNOLOGIES

The use of these systems to augment substitution has been forecasted by many observers. Interpersonal visual communications can take the form of randomly switched calls between individuals using a technology such as the U.S. Bell System's Picturephone. Interpersonal visual communications can also take the form of point-to-point teleconferences between groups of individuals using systems such as Confravision in the U.K. or Bell Canada's Conference TV system. The Confravision system has recently been extended to Sweden, and other European countries are reported to be planning to join this growing network. In the U. S., the Bell System has introduced a three city (Washington, New York, and Chicago) conference television based upon Picturephone technology. The Australian Post Office has also been using a Confravision system for several years. One of the prime reasons advanced for using these systems is to cut back inter-city travel.

The systems discussed above are all directed toward inter-city communication. The question of intra-city video conferencing has also been tested but not on such a wide-scale basis. The Metropolitan Regional Council around the New York City area has been using a multiple location video conference network for local use during the past year. This system has been used to replace travel within the New York City area for meetings between the local politicians and civil servants, and for remote training sessions. Interactive television systems (audio return paths only) have been used at Stanford University and The University of Southern California for several years to reduce student travel to classes or provide educational training to employees right at their remote job locations. Both inter- and intra-city systems offer the ability to interact with images of speakers at remote locations and to share pictures, diagrams, and graphics.

It should be restated here that significant future substitution would not be expected to take place through the use of Conference TV or Videophone alone. It is the combined pressure from the **overall collection of technology capabilities that is being reviewed here.**

COMMUNICATIONS SATELLITES

Communications satellites have grown from experimental vehicles to key components of national and international communications systems in the past decade (both for broadcast and interpersonal communications). Canada was the first country in the world to use synchronous orbit domestic satellites for broadcast and interpersonal communications within a nation. While there are abundant east-west communications systems within Canada, the satellite permits communications into the far north of Canada where other systems could only provide delayed broadcast or periodic telephone service. This technology is viewed as an important means of linking residents of the North into the communications mainstream of Canadian life. In the U.S. domestic satellite service has recently been introduced by the Western Union Company. This system will also provide nation-wide telecommunications service to both end users and other common carriers.

Communications satellites may be a factor in other substitution questions as well. These satellites have been projected as means of linking up many urban cable TV or local broadband systems into nationwide networks. They may also be used to provide lower cost video channels for interpersonal visual com-

munications *systems* such as Videophone or Conference TV. However, in both of these cases, their impact is secondary since the satellite only provides raw communications channels to these other systems, which in turn provide user-oriented services that could augment the substitution process. Analysis of the impact of future broadband communications or visual teleconferencing systems should include the impact of any satellite communications as a sub-component rather than as an entity in itself,

INFORMATION STORAGE AND RETRIEVAL SYSTEMS

Communications technologies in themselves are not the only technologies that will have an impact on the substitution process. The complex merging of *com*puter power and communications systems is leading to a whole new order of significant technologies. The development of "on-line" (i.e. communications-linked) time-sharing systems that provide a host of personalized information storage and retrieval capabilities, text editing, and computational power is creating the possibility of utilizing remote work centers with the required access to computer systems needed to accomplish a task. Developers of very advanced, but user-oriented (the "dumb" user from a computer viewpoint) systems see them as creating "augmented knowledge workers" over time. (9) They foresee an evolution in work styles and capabilities as knowledge or post-industrial workers utilise the power in these systems. This could have considerable impact on the intra-urban substitution question since these systems can be routinely accessed from any location that has a telephone.

COMPUTER NETWORKS

The evolution of several advanced forms of computer networks in North America will reinforce the tendencies outlined in the above section. Linking through relatively inexpensive communications networks permits specialization of computer capabilities at various geographic locations. The Advanced Research Projects Agency (ARPA) has financed the development of one such system in the U.S.A. that is now being extended (via satellite) to Europe, Hawaii, and the Far East. This resource-sharing of specialized computer systems will assist in further augmentation of knowledge workers and impact on the need for both intra- and inter-urban travel. Several commercial versions of these forms of computer networks are being introduced in the U.S. The Trans-Canada Telephone System is also introducing a common user-packet switched-data network in the next year. Plans for experimental networks have been also announced by most European telecommunications authorities and by the Japanese telecommunications organization.

COMPUTER-AUGMENTED CONFERENCING (CAC)

CAC connects a number of individuals with computer terminals to the computer in a synchronous or asynchronous mode, permitting them to approximate the interactions that they might experience if they were engaged in face-to-face communication as well as providing new capabilities not currently available with face-to-face or electronic communications. The number of participants in a computer-augmented conference can vary from two to as many as twenty or more. Since the communications process is asynchronous, many conferees can input their comments to the conference at the same time: when they have finished their input, the computer delivers the messages that have arrived during the input phase. A text editing facility may also be included in the CAC package.

Computer conferencing provides another means of merging computer and communications systems power to help create alternatives to travel. The technique is also being used as a research vehicle by the BPG. In the past, audio-teleconferences have been sponsored by the group among over twenty" different individuals associated with institutions studying various aspects of the substitution question. This program has been expanded to include interactive computer conferences on the same subject.

OTHER TECHNOLOGIES

This analysis of the technological issues that are stimulating interest in the substitution area is only a brief overview of the energy possibilities. Each of the technologies discussed above can be explored in much greater detail in the various references given. Many other relevant technologies that will have a bearing on the future process of substitution have not been discussed. These include, intelli-

gent terminals , video discs and cassettes, audio cassettes, video data banks, audio data banks, computer-based education systems, facsimile transmission, graphic communications, still-frame TV transmission, artificial intelligence systems, and voice input to computers. The main purpose of this section of the article was not to be all-inclusive, or to review any particular technology in detail, but to give a flavor of the technological revolutions whose combined strength will certainly cause a conscious re-evaluation of many future decisions to travel.

APPENDIX 3 : BUSINESS PLANNING PUBLICATIONS

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Michael T. Bedford, A Technology Assessment of Future Residence Communications Services, Volume 1 Working Papers, Business Planning Group, Bell Canada, Montreal, Canada, January 1976.

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James H. Kollen/John Garwood, Travel/Communication Tradeoffs: The Potential for Substitution Among Business Travelers, Business Planning Group, Bell Canada, Montreal, Canada, April 1975.

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BPP#2—Internal distribution only.

BPP#3—Lawrence H. Day, "The Future of Man-Machine Information System Use by Non-Computer Professionals" Fourth International Symposium on Cornputer and Information Science (COINS–72), Miami, Florida, December, 1972. (slides only)

BPP#4--Lawrence H. Day, "Design of a Futures Information System", Second Annual Computer Communications Conference, San Jose State University, January, 1973.

BPP#5--Lawrence H. Day, "Long Term Planning in Bell Canada", Long Range Planning, London, England, September, 1973.

BPP#6--Lawrence H. Day, "The Future of Computer and Communications Services", National Computer Conference and Exposition, New York, N. Y., June, 1973.

BPP#7—Lawrence H. Day, "Instant Retrieval Television: From Theory to System", First Annual Computer Communications Conference, San Jose, Calif., January 1972. (abstract only)

BPP#Donald M. Atkinson, "The Societal Side of the Wired City", First Annual Computer Communications Conference, San Jose, Calif., January 1972. (abstract only)

BPP#9--Internal distribution only.

BPP#10-Anthony D. Ryan, Cross Impact Analysis for Bell Canada,.March 1973.

BPP#11—Donald M. Atkinson, Three Papers on Telecommunications and Social Environment with and Impact on Business, April 1973.

BPP#12—Michael T. Bedford, A Technology Assessment of Future Communications Services in the Home: A Study Proposal, May 1973.

BPP#13—Lawrence H. Day, "The Corporate Role in Technology Assessment: A Case Example", First International Congress on Technology Assessment, The Hague, The Netherlands, May, 1973. (See also journal paper in: Technology Assessment),

BPP#14--Michael T. Bedford, "Technology Assessment and the Future of Educational Technology", Thirtieth Annual Science Council Conference, Alberta Teachers Association, Banff, Alberta, May, 1973.

BPP#15--Philip Feldman, Cross Impact Matrix Applications in Technology and Policy Assessment, Sept. 1973.

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BPP#28--Kenneth S. Hoyle, Legal-Political Considerations for Effective Planning, American Society of Mechanical Engineers Conference, Mexico City, October 1974.

BPP#29--James H. Kollen, Replacement of Travel by Telecommunication, October 1974.

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BPP#32—James H. Kollen, New Perspectives On the Travel/Communication Tradeoff-December 1974.

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BPP#50--Michael Katsoulis, Travel/Communications, Substitution—Its Potential for Energy Conservation in Canada., February 1976.