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1994

TELECOMMUNICATIONS RESEARCH AND DEVELOPMENT IN CANADA

NGL Consulting Ltd.
Consultants Ltée

September 16, 1991

Marcel Richard
Procurement Officer
Department Of Communications
Materiel Management and Contracting Services
Journal Tower North
300 Slater Street
Room 1738
Ottawa, Ontario
K1A 0C8

Dear Mr. Richard:

RE: Department of Communications Request for Proposal: Telecommunications R&D Study

We are pleased to submit the attached proposal on Telecommunications R&D in Canada. We are very interested in assisting the Department of Communications to develop a thorough understanding of telecommunications R&D in Canada and the influencing factors that pertain thereto.

We have assembled a very experienced team to ensure that the best possible service is provided. As we trust our proposal demonstrates, this experience will enable the team to undertake the project without any learning curve delay or wasted effort.

The project director, Dr. Tom Grandy, Partner in charge of NGL's telecommunications practice is a senior consulting professional with former strategic planning responsibilities in the telecommunications industry, extensive knowledge of the telecommunications policy and regulatory environment and R&D experience at Bell-Northern Research.

Dr. Roger Voyer, Partner in charge of NGL's science and technology practice, brings a broad knowledge of R&D, both in Canada and abroad. He is particularly knowledgeable regarding the developing definitions of R&D and their application for policy and regulatory purposes. We are pleased to include on our team, Dr. Denzil Doyle who brings a direct working knowledge of Canada's high technology sector and the role of R&D, particularly related to competitiveness.

280, rue Albert Street, Ottawa, Ontario, Canada K1P 5G8 Tel: (613) 236-5850 Fax: 236-9241

The team is rounded out by two of NGL's consultants, Mr. Kevin Smith and Mr. Les Routledge who have a thorough grounding in business planning and strategic analysis.

We look forward to working with the Department of Communications on this important assignment.

Yours very truly,

Thomas B. Grandy

Thomas B. Grandy, Ph.D.
Partner

TBG/ww
Encl.

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Proposal Submitted to:

Department of Communications
300 Slater Street
Ottawa, Ontario

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TECHNICAL PROPOSAL

1.0 OUR UNDERSTANDING OF YOUR REQUIREMENTS

This section of the Proposal presents our understanding of the study requirements as outlined in the Request for Proposal (RFP). It provides a background for presentation of our proposed Approach and Methodology in Section 2.0. In the first subsection below, we state our understanding of the objectives of the study. In the second sub-section we provide a perspective on the Canadian telecommunications equipment and service sectors. In the third sub-section, we summarize the key issues and state of Canadian telecommunications research and development (R&D) in a global context, and highlight some of the aspects of this sector which will require examination in the development of options and policies to respond to the objectives of this study.

1.1 Study Scope and Objectives

The setting of a consistent R&D policy requires a thorough understanding of telecommunications R&D in Canada and its international context. Such policy would have two main objectives, namely:

- to strengthen the competitive position of Canada's telecommunications industry in the medium and long term (and thus reverse the negative trend in the balance of trade in this sector); and
- to ensure that Canadians and Canadian businesses have access to world class communications facilities, products and services into the next century (and therefore improve the competitive position of other industrial sectors).

The purpose of this study is to conduct a detailed assessment of telecommunications R&D in Canada relative to such factors as:

- the competitive environment facing Canadian companies;
- the role that R&D plays within this competitive environment;
- the regulatory, financial, policy, and institutional factors affecting telecommunications R&D; and
- the constraints to conducting R&D.

The output of this study would consist of two papers: the first an interim report detailing a comprehensive database of the state of telecommunications R&D in Canada (carriers,

manufacturers, universities, governments; R&D performance, R&D expenditures, spending instruments, ratios between long term R&D and short term R&D); and the second, a comprehensive report presenting a situation analysis, international points of comparison, and options regarding R&D mechanisms and policies to meet the goals of DOC and ISTC. In presenting the policy options and potential ramifications the two papers will be used by government to develop policies for telecommunications R&D, to ensure that Canadians and Canadian organizations have access to world class communications facilities, products and services.

1.2 The Canadian Telecommunications Industry

This subsection provides the key characteristics of the telecommunications industry in Canada. We outline the companies and operating characteristics of telecommunications equipment manufacturers in the subsection 1.2.1, and the service providers in subsection 1.2.2.

1.2.1 The Canadian Telecommunications Equipment Industry

The Canadian telecommunications equipment industry sector consists of some 500 companies that develop, design and manufacture the sophisticated equipment which is used to provide telecommunications services in Canada and around the world. It produces revenues of over $5 Billion per year, and indirectly results in the production of revenues many times this amount. This compares to a global market estimated to be in the order of $127 Billion[1] in 1989. In addition to being of strategic importance in its own right, the telecommunications industry in Canada is an important contributor to the competitive position of Canadian manufacturing, service and resource processing industries throughout the country.

The sector is dominated in Canada by one multi-national company, Northern Telecom, which accounts for about one half of domestic shipments. Other major players include Mitel Corporation, Motorola Canada Ltd., Newbridge Networks Corporation, Gandalf, Novatel, Spar Aerospace, Canadian Marconi, Glenayre, etc. In addition, there are a number of smaller companies supplying a range of niche products or supplying components and sub-assemblies to the major suppliers. Much of the sector is

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[1] NGL Consulting Ltd. in association with The Coopers of Lybrand Consulting Group and Collyn Managements, "A Proposal Towards a Strategic Plan for the Canadian Telecommunications Equipment Industry: Part II - A Framework for Action", Prepared for Industry, Science and Technology Canada and the Canadian Telecommunications Action Committee, January 1991, p.7.

domestically owned and controlled. However, many are foreign owned/controlled, including those which were acquired (like Mitel) and foreign multi-national companies, which have a significant capability in Canada. A sampling of the capabilities of Canadian based firms is shown in Exhibit 1-1.

The structure of the telecommunications equipment market is closely linked to that of the service industry and its regulatory framework. In Canada, two of the major equipment suppliers have traditionally had corporate linkages with the two largest operating companies: Northern Telecom with Bell Canada, and MPR Teltech (formerly Microtel) with B.C.Telephone. This industry structure, in the past when such linkages were common around the world, fostered strength in the Canadian telecommunications equipment industry. The exclusivity of such linkages is, however, coming under question in Canada and elsewhere as competition, deregulation and privatization sweep the world. In fact, the Science Council of Canada recently recommended that federal and provincial governments consider the option of deregulating the Canadian telecommunications industry to open up new hardware and service opportunities at home and to make the Canadian telecommunications industry more competitive abroad.[2]

The sector directly employs over 40,000 Canadians and indirectly results in employment several times this number. The employment in this sector decreased over the 1980's due a decline in labour intensity of production with growing automation and has only recently begun to increase. This shift has been accompanied by a changing mix of skill towards more sophisticated knowledge-based skills as the "knowledge-intensity" of the sector increases.

1.2.2 Canadian Telecommunications Services Sector

The Canadian telecommunications service sector is composed of a mixture of public, governmental and joint private-governmental corporations and organizations. The key participants in the industry together with their operating territories are summarized in Exhibit 1-2. The companies which are the likely targets of this study comprise the following:

(1) Members of Telecom Canada

- an unincorporated association of the largest telephone company in each province and Telesat Canada, the domestic satellite carrier.

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[2] Science Council of Canada, Sectoral Technology Series, No. 1, "The Canadian Telecommunications Sector," May 1991, p. 34.

Exhibit 1-1
The Canadian Telecommunications Equipment Industry
Selected Participants (1989)

	Public Switching	Transmission	Cable	Satellites	Data	Private Switching	Other CPE	Mobile
AEG Bayly		•			•			
Canadian Marconi		•			•			
Canstar		•	•					
COM DEV		•		•				
Develcon					•			
Eastern Independent	•							
Eicon					•			
Gandalf					•			•
GE-Ericsson								•
Glenayre								•
GPT (Canada)	•	•		•				
Harris Farinon		•						
International Datacasting				•	•			
Memotec		•			•			
MITEL	•					•	•	
Motorola Canada					•			•
MUX Lab					•			
Newbridge		•			•			
Northern Telecom	•	•	•		•	•	•	•
NovAtel								•
Omicron		•			•			
Phillips Cables			•					
Pirelli Cables			•					
Positron		•			•	•		•
SED				•				
Spilsbury		•						•
SPAR Aerospace				•				
SR Telecom		•						
TIE/Canada						•		
TIL					•			
Ultimateast		•				•		•

Source: NGL Consulting Ltd. et al, "A Proposal Towards a Strategic Plan for the Canadian Telecommunications Equipment Industry - Part I," Prepared for ISTC and CTAC, January 1991, p. 10.

Exhibit 1-2
The Canadian Telecommunications Services Sector
Selected Participants

COMPANY	OPERATING TERRITORY
Telecom Canada Members	
Newfoundland Telephone	Newfoundland
Maritime Telegraph and Telephone	Nova Scotia
Island Telephone	Prince Edward Island
New Brunswick Telephone	New Brunswick
Bell Canada	Ontario and Quebec
Manitoba Telephone	Manitoba
Saskatchewan Telecommunications	Saskatchewan
AGT	Alberta
British Columbia Telephone	British Columbia
Telesat Canada	Canada
Major Independent Telephone Companies	
Québec - Télephone	Eastern Quebec
Télébec Ltée	Eastern Quebec
Thunder Bay Telecommunications	Thunder Bay, Ontario
Northern Telephone	Northern Ontario
"edmonton telephones"	Edmonton, Alberta
Northwestel	Yukon, Northwest Territories and Northern British Columbia
Other Major Facilities-Based Carriers	
Unitel Communications Inc.	Canada
Teleglobe Canada	Canada
B.C. Rail	British Columbia
Radio-based Companies	
Cantel Inc.	Canada
CallNet Canada (consortium of wireline cellular companies)	Collectively across Canada
Radio Common Carriers	
Approximately 200 Companies	Individually throughout Canada
Enhanced and Resale Carriers	
Growing number of carriers, approximately 40 resale	Data - generally throughout Canada Voice - Bell Canada and B.C. Tel Territories

Source: NGL Consulting Ltd., "Changes in the Telecommunications Environment: 1991-2000," Prepared for the Ontario Ministry of Culture and Communications, March 1991, p. 1-3.

(2) Independent Telephone Companies

- there are 30 independent telephone companies in Ontario and 16 in Quebec, the largest of which are Northern Telephone and Thunder Bay Telecommunications in Ontario and Québec-Téléphone and Télébec in Quebec;

- the primary independents in other areas of the country include "edmonton telephones" in Edmonton and Northwestel operating principally in the territories.

(3) Other Major Facilities-Based Carriers

- Unitel Communications Inc. and B.C. Rail offer a range of competitive telecommunications services and have applied to the CRTC to compete in public switched long distance;

- Teleglobe Canada provides facilities or otherwise arranges for telecommunications services between Canada and overseas locations.

(4) Cellular Telephone Service Providers

- the cellular telephone companies provide a radio-based portable telephone service interconnected to the public switched telephone network. Service is provided on a duopoly basis by Cantel Inc., a national carrier, and by telephone company affiliates (co-ordinated on a national basis by an association of these companies called CellNet Canada).

The Canadian telecommunications services industry is valued at $16 Billion. This is dwarfed by the world market of $360 Billion in telecommunications services. This world market is expected to grow by the year 2000 to $1.2 Trillion[3].

Canadian telecommunications regulators face growing pressures to permit increased competition in the industry. Competition in the telecommunications industry in the U.S., the U.K., and Japan have brought increasing pressure on the Canadian regulatory system. In particular, competition in the provision of long distance services in the U.S. has resulted in significantly lower long distance rates in the U.S. than in Canada. Whereas to date, competition has been permitted in a number of areas, for example data, private line voice, resale of private line services and facilities, cellular, etc., substantial pressure

[3] Science Council of Canada, Sectoral Technology Series, No. 1, "The Canadian Telecommunications Sector," May 1991, p. 14.

exists to permit facilities-based competition in the core area of public switched long distance service. Such competition, it is argued, would increase innovation, stimulate R&D, increase the availability of services, improve the industry's productivity etc., to the benefit of Canadian users and industry.

Changes in industry structure and participants are driven by policy and regulations regarding the extent of competition, the needs of the market, technological change and global competitive forces. Canadian telecommunications policy makers and regulators will face an increasingly complex environment over the next decade. Pressure will increase to simplify and speed the regulatory process, and to develop more effective policies and regulation. The policy and regulatory environment may be broadly characterized as follows:

- a continued requirement to ensure universal provision of basic telephone service at affordable rates;

- pressure to view telecommunications in a broader context, namely as part of the industrial and economic policy that enhances the overall competitiveness of Canadian industry and enables the delivery of more cost effective services to the public;

- external pressure to harmonize Canadian policy and regulation with the growing trend towards deregulation, liberalization and competition in the world.

Market liberalization combined with the emergence of powerful new technologies are opening a range of market opportunities for telecommunications service providers. What was once a unified industry is becoming fragmented and highly competitive. It is expected that changes will occur with respect to all key participants in the industry, including new facilities-based long distance competitors, increased number of resellers, increased significance of wireless participants, increased global strategic alliances, and increased participation by users in the industry.

Competition is also expected to produce changes in service availability in the 1990's. There will be a significant increase in the availability of voice, data, image and video services. Factors and trends that will contribute to increased availability include the following:

- increased demands by business and institutional users for new applications and telecommunications service and pricing options;

- globalization of telecommunications leading to more international services;

- increased presence of U.S. service providers;
- increased competition by equipment manufacturers leading to new applications as well as managed network services;
- the development of standards on a global basis;
- the deployment of fibre optics which will provide inexpensive high bandwidth;
- the development of intelligent networks which will increase the range of available services;
- the upgrading of the public switched telephone network (PSTN) to integrated services digital network (ISDN) which will enable easier access to voice, data, image and video services from the desktop, and thereby stimulating those services.

Underlying the changes in capabilities are the developments, through R&D, in network structure and technology. The major trends in this area are:

- the deployment of fibre optics transmission systems (FOTS);
- digitization and the distribution and development of ISDN (narrowband and broadband) products;
- development and deployment of synchronous optical network (SONET) technologies;
- use and development of higher speed network protocols such as frame relay, asynchronous transfer mode (ATM) and SONET;
- development of Bandwidth-on-Demand services and multi-point protocols, and new multi-media applications and services;
- development of advanced facilities and network control;
- developments in satellite systems and the interconnection to mobile, cellular, radio systems;
- advances in video technologies in areas such as standardization with

respect to compression, business video, video-conferencing;

- increased use of artificial intelligence through integration into services such as MTS and WATS, voice recognition and response;
- data broadcast technologies including increases in lines transmitted, standardization of protocols;
- development and widespread availability of wireless services such as wireless PBX's and LAN's;
- advancement in wireless personal communications technologies, CT2 and CT3;
- advanced software.

1.3 The State Of Canadian Telecommunications R&D In A Global Context

The telecommunications industry represents a vital element of the "Information Age" that Canada has entered. The sector is undergoing fundamental structural changes throughout the world. Telecommunications has become a global industry due to a more liberalized regulatory environment, rapid growth in demand for products and services driven by rapid technological progress and the battle to maintain and improve competitiveness in the international arena. This battle is an on-going struggle in which singular achievements will not guarantee ultimate success.

Canada has been a world leader in the telecommunications industry, and has earned a high reputation at home and abroad for its achievements in telecommunications R&D. However, this position is being eroded as indicated by Canada's negative trend in the telecommunications balance of trade. It has been commonly assumed that R&D is directly related to the competitiveness in the communications sector. The study must place particular emphasis on the validity of this assumption and develop a correlation between a policy which encourages R&D and the competitiveness of the sector. The goal of R&D related to competitiveness would be to produce a continuous stream of innovative products and services, but this addresses the problem of the nature of R&D. The issue of how to fund and promote the right kind and level of research over the appropriate time-frame must be addressed.

The most intensive sector for R&D in Canada is in telecommunications equipment. (Exhibit 1-3 details R&D expenditures of selected Canadian companies). In fact, 18% of the total R&D reported for 1988 by Statistics Canada was directly related to

Exhibit 1-3
1989 R&D Expenditures of Selected Canadian Companies
($ Million)

COMPANY	Revenues[1]	Gross R&D Expenditures[2]	R&D Expenditures / Revenue (%)
Canadian Marconi Company[3]	15.2	1.7	11.2
Develcon Electronics Ltd.	11.3	2.4	21.2
Gandalf Technologies Inc.	167.4	17.9	10.7
Glenayre Electronics Ltd.	108.3	8.0	7.4
Memotec Data Inc.[4]	72.4[5]	11.9	17.7
Mitel Corporation	432.1	55.3	12.8
MUX LAB Inc.	7.4	0.8	10.9
Newbridge Networks Corp.	67.4	11.7	17.4
Northern Telecom Ltd.[6, 7]	7,161.0	948.0	13.2
SPAR Aerospace Ltd.	233.2	20.0	8.6
SR Telecom Inc.	29.8	6.1	20.5
TIE/Communications Canada Inc.	66.7	3.4	5.0
TOTALS	8,367.0	1,088.0	13.0

Source: Company annual reports

Notes:
(1) Worldwide Revenues
(2) Worldwide R&D Revenues (includes contracted R&D)
(3) Estimated amount for telecommunications (assumed to be 5% of total)
(4) 1988 figures
(5) Product Revenues only
(6) Converted to Canadian dollars @ 1.1728
(7) 70% of R&D employees are in Canada.

Source: NGL Consulting Ltd et al, "A Proposal Towards a Strategic Plan for the Canadian Telecommunications Equipment Industry, Part I", Prepared for ISTC and CTAC: January 1991, p. 32.

telecommunications. Canadian companies, as can be seen by Exhibit 1-4, perform well against international equipment manufacturers in investment in R&D as a per cent of sales. However, in absolute terms, Canadian expenditure on R&D is dwarfed by its international competitors who have organizations that are larger, have access to more finances, have access to larger markets and in some instances receive greater support from their governments.

Exhibit 1-5 indicates the 1989 R&D expenditures of the major Canadian facilities-based carriers, and indicates that investment by this group is much smaller as a percent of sales. R&D expenditures for 1988 are contained in the DOC Discussion Paper: R&D Strategy for the Telecommunications Industry.

The European Community, the U.S. and Japan have all identified information technology, including telecommunications, as a major area for development:

- A European thrust in the drive for unification is the deregulation of the telecommunications environment and liberalization of European Community telecommunications markets. The European Community has created an Information Technologies and Telecommunications Task Force which has developed a program to promote the industry and which include initiatives to undertake common R&D, open market competition in terminal equipment and value-added services and broaden procurement policies. The ESPRIT programme (European Strategic Performance for Research in Information Technology) had a budget of $2.2 Billion for Phase I ($4.4 Billion for Phase II) and has been upgraded as part of RACE (Research in Advanced Communications technology in Europe) which is mainly designed to develop Europe's ISDN and broadband capabilities and has a 1987-1992 budget of $1.4 billion[4]. Further, EUREKA a program which in part supports the development and commercialization of mobile and vehicular communications equipment has a budget of approximately $6.4 billion.

- In the U.S., federal intervention in support of the telecommunications industry has principally been through the support of R&D in the interests of national security such as the research activities of the Defense Advanced Research Projects Agency (DARPA) in computer networks and their current involvement with HDTV research.

[4] Department of Communications,"International R&D Collaborative Programs", March 1990, Appendix I.

Exhibit 1-4
1989 R&D Expenditures for Selected Global Equipment Suppliers

COMPANY	COUNTRY	R&D Expenditures ($US Billion)	R&D/Sales (%)
Siemens	West Germany	3.50	10.5
NEC	Japan	3.40	15.9
AT&T	U.S.A.	2.60	7.3
Hitachi	Japan	2.50	6.5
Fujitsu	Japan	1.50	9.3
Alcatel	France	1.30	10.0
Northern Telecom	Canada	0.71	13.1
Motorola	U.S.A.	0.66	8.1
LM Ericsson	Sweden	0.58	11.3
AEG	West Germany	0.52	8.0
Plessey	U.K.	0.17	7.2
Harris	U.S.A.	0.12	5.7
TOTAL		17.60	9.4

Source: NGL Consulting Ltd. et al, "A Proposal Towards a Strategic Plan for the Canadian Telecommunications Equipment Industry - Part I", Prepared for ISTC and CTAC, January 1991, p. 33.

Exhibit 1-5
Revenues and R&D Expenditures of
Major Canadian Telecommunications Carriers, 1989
($ Millions)

COMPANY	Revenues	R&D Expenditures	R&D Expenditures as a % of Revenues
Telecom Canada Members			
Bell Canada	7,272.9	140.2	1.90
B.C. Telephone	1,689.6	31.3	1.80
A.G.T.	1,162.8		
SaskTel	553.5	2.4	0.43
M.T.S.	516.6		
M.T.&T.	453.5	1.2	0.26
N.B. Tel	305.5	2.0	0.65
Nfld. Tel	249.7	0.359	0.14
Island Tel	48.1	0.113	0.23
Other Telecom Carriers			
Unitel	370.4	N/A	N/A
Teleglobe	237.0	7.8	3.30
Telesat	146.5	0.915	0.62

Source: Telecommunications Research and Development Statistics, DOC, July 1991

- Japan, as a major practitioner of industrial policy, has consistently demonstrated the ability of government, business and labour to reach consensus on national goals as well as in the structuring of policies. MITI's R&D policies are structured for cooperation. Incentives are built around direct governmental financial support and other assistance such as: accelerated depreciation, leasing backed by the government, government licensing of patents and near monopoly government procurement. An example is the long-term investment in the Frontiers Research project in intelligent networks and high capacity transmission.

It is thus important to analyze the Canadian R&D environment against valid international comparisons, and to derive a fundamental rationale for determining the level of Canada's R&D expenditures that would be necessary to maintain a competitive industry. The encouragement of R&D can be accomplished through a variety of mechanisms, including communications and industrial policies, funding (tax credits and direct funding), collaborative R&D and alliance building. Many of these mechanisms already exist in Canada, so it will be necessary to determine to what degree Canadian manufacturers and carriers are taking advantage of current tax provisions, credits and other incentives. Further, how Canadian organizations perceive impediments to R&D activities is important in defining the effectiveness of the various mechanisms and in understanding what changes, if any, are necessary for the definition of R&D used by various governmental authorities (Revenue Canada, DOC, ISTC, Statistics Canada).

R&D in Canada tends to be highly concentrated among the larger organizations. The problem is that the large organizations do not necessarily have the monopoly on ideas or responsiveness to market needs in terms of applications, and small companies don't have adequate resources to mount comprehensive or foundational R&D programs. It will therefore be necessary to look at models for collaborative R&D and determine how R&D effectiveness can be maximized.

As noted above, the regulatory environment in Canada is under pressure for change to allow for more competition in the provision of services. The ramifications of increased competition and the ability to allocate funds to R&D becomes an important issue. If R&D funded by the federally regulated carriers were to be changed, how this would affect rate bases and rates. Therefore, direct implications on the Canadian economy and Canadians must be analyzed. The effects of increased competition can potentially be determined from the experiences of the U.S., the U.K., Japan and possibly New Zealand, Australia, and Sweden. In analyzing the foreign situation it can be determined what effects (if any) on the levels and nature of R&D spending can be expected.

Other major factors affecting the competitiveness of the telecommunications industry include:

- economic factors such as exchange rate, cost of capital, the supply of skilled labour and associated affects on foreign price competitiveness;

- institutional and market factors including bottom-line short term focus of Canadian firms, structural considerations and the role of research tax credits; and

- foreign practices and procedures relating to industrial policies, procurement policies (trade barriers, buy national), technical standards, patents, testing and certification procedures and other agenda items regarding attempts to enter their markets (e.g. leased line and value-added service restrictions).

DOC and ISTC require better information as to the effectiveness and pay-off of telecommunications R&D. The study will therefore analyze whether higher levels or focused R&D is enough to enhance long term competitiveness, or whether other factors such as the above intervene.

2.0 APPROACH AND METHODOLOGY FOR THE STUDY

This section describes the proposed approach and methodology to be utilised. The first subsection provides an overview of the approach. Subsequent subsections outline in detail the specific steps to be adopted in responding to the requirements of the RFP.

2.1 Overview of Approach and Methodology

Exhibit 2-1 provides a graphical overview of the methodology that we propose to follow. The project would consist of four main activities as follows:

I. Project Planning

II. Situation Analysis of Canadian Telecommunications R&D

III. Strategic Analysis of Telecommunications R&D in Canada

IV. Final Project Reporting

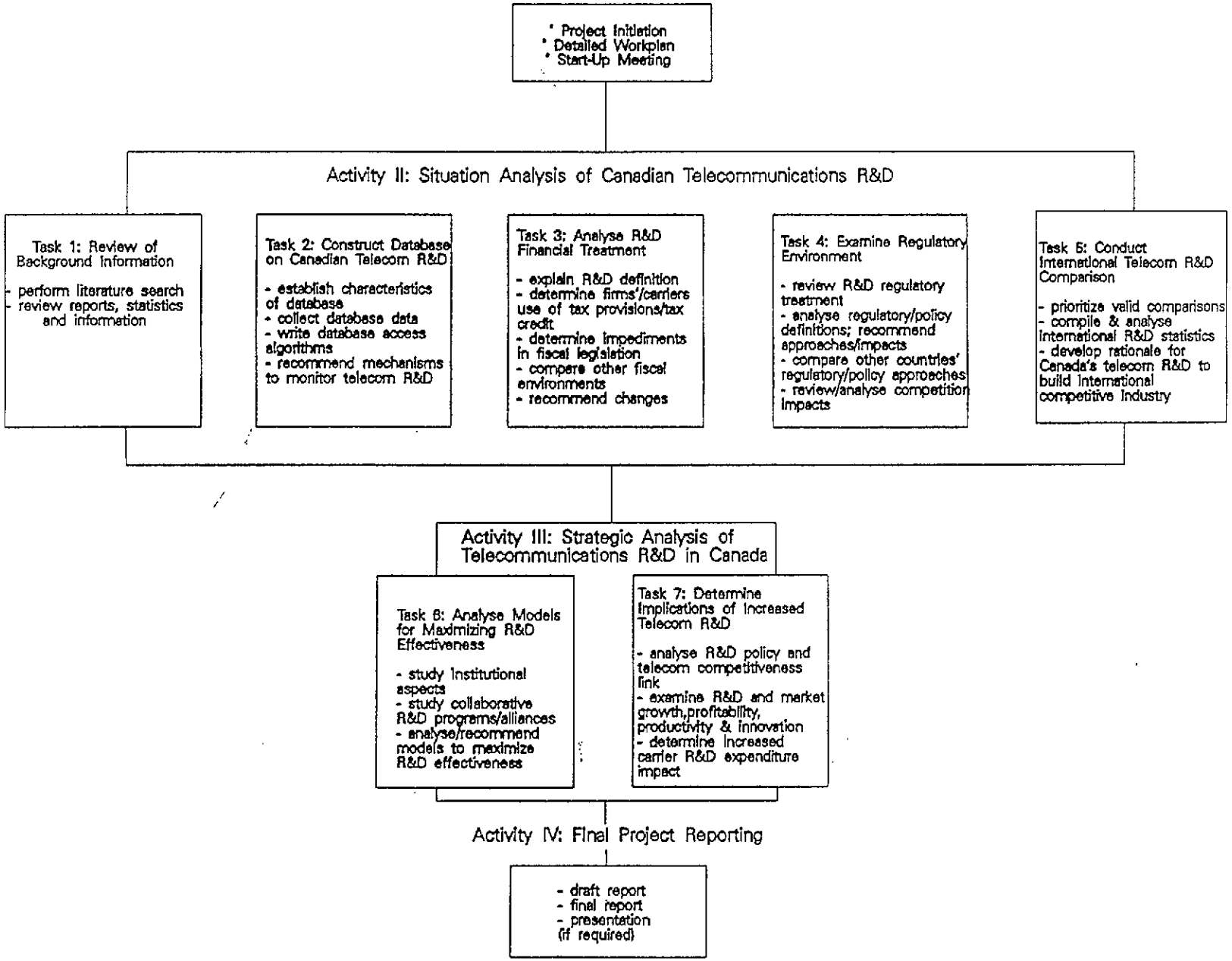
There are a number of key strengths to our approach which we would like to emphasize. Our methodology encompasses four major activity groups which are organized to provide comprehensive and consistent information at all stages. In particular, Activity II proposes the parallel execution of the five tasks comprising the situation analysis to ensure coherent input into Activity III. In doing this, not only are all tasks placed into a broader international context but industry and government contact requirements are minimized. There are sufficient multiple management and staffing cross-overs between tasks to ensure progress checks and collaboration between tasks.

The following sub-sections present the specific tasks to be undertaken within each of these project activities.

2.2 Activity I - Project Planning

Immediately upon award of contract, we will detail the work schedule indicating task-completion dates and the effort required for each task and sub-task, as well as updating the naming of individuals responsible for their completion. As indicated later, we have provided in our proposal, a general outline of tasks which will serve as the starting point for the development of the detailed work schedule. This work plan will be submitted to the project authority within one week after the award of contract.

Exhibit 2-1
Overview of Approach and Methodology



We propose that the work schedule be reviewed with the project authority in a start-up meeting within two weeks of the contract award. At this meeting, we will review our approach and methodology, including sources of information, interview guidelines and proposed interviewees. This will permit us to subsequently include into the project planning any agreed changes at an early stage, and obtain approval of the work plan.

2.3 Activity II - Situation Analysis of Canadian Telecommunications R&D

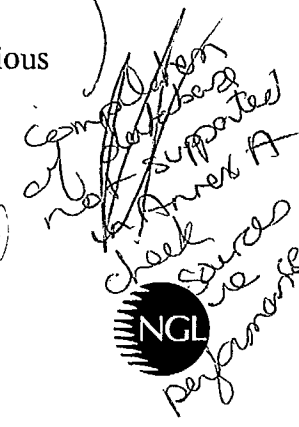
This subsection relates directly to Tasks 1 through 5 of the RFP to review the state of the Canadian Telecommunications R&D and to develop a comprehensive R&D database for carriers (integrated and non-integrated), equipment manufacturers, universities and governments; and will analyze the environment facing telecommunications R&D in Canada including the financial treatment of R&D, the regulatory environment, and an international comparison of telecommunications R&D. An interim report covering the results of Task 1 and Task 2 will be submitted in five copies to the project authority three months after the contract award date.

2.3.1 Task 1 - Review Of Background Information

As an initial stage in this project, NGL will review documents currently at our disposal, reports and documentation provided by the contract authority, and relevant documentation uncovered in a comprehensive literature search. NGL support and library staff have extensive experience in gathering and sorting information regarding Canadian high technology sectors from domestic and international sources. As well NGL has an extensive database of relevant literature on the telecommunications industry, including a number of our own studies as listed in Appendix A.

2.3.2 Task 2 - Database of Canada's Telecommunications R&D

NGL is skilled in the collection and compiling of various types of sector specific data from both private and public sector organizations. We have developed a systematic data collection methodology which has proven effective in the collection of variety of information including foreign investment intentions, financing requirements and opportunities, export intentions, and product development intentions in technology intensive sectors. In previous assignments, we have collected information from various industry sectors including broadcast equipment suppliers, telecom equipment manufacturers, mobile satellite equipment manufacturers, and telecommunications service providers. Details of these assignments are provided in Appendix A.



We have adapted our methodology for the unique requirements of this assignment and have developed the following data collection methodology:

- *Stage 1: Determine Information Requirements* - During this stage, we will review published sources of information on telecommunications R&D in Canada, access public information databases (e.g. BOSS, Statistics Canada, CANTEC, EVERT database on R&D, etc.). Further, we will examine existing NGL and project authority information to determine the appropriate information sources and the type of information required, and augment those areas as necessary;

- *Stage 2: Collect the Data* - In previous assignments, we have found the most effective method to collect high quality data from organizations requires at least three contacts as follows:

  - initial telephone contact to introduce NGL, explain the project, and request the firm's cooperation;

  - send a written request for information and a brief explanation of the project (i.e. information requirements, intended use of the information, etc.) to the contact person by facsimile after securing their commitment to cooperate;

  - contact the recipient within twenty-four hours to answer any questions and to encourage a timely response.

- *Stage 3: Compiling the Data* - We will develop a consistent framework to classify the responses of organizations which will enable the results to be updated over time. The framework will facilitate iterative analysis so the information can be categorized by several parameters including province, size of firm, number of employees, ownership structures, and research categories. In addition, the framework will strive to maintain consistency with data collected by other organizations such as industry associations, Statistics Canada and Revenue Canada. Information collected will be maintained in an electronically readable format for ease of future access, retrieval and formatting.

Approximately 80 organizations will be requested to provide information for the database. These organizations will include:

- Telecom Canada members and major independent telephone companies;

- Unitel, Telesat, Teleglobe, Cantel, and CellNet;

- major telecommunications equipment manufacturers;
- universities and other academic institutions involved in telecommunications R&D;
- government laboratories and centres of excellence, both federal and provincial.

Throughout the execution of this task, the project team will investigate alternative methods that could be used to monitor telecommunications R&D activities in an ongoing manner, possibly in collaboration with other agencies (e.g. Statistics Canada, ISTC, CRTC, etc.) or with industry associations.

2.3.3 Interim Report

An interim report covering the results of tasks 1 and 2 will be submitted to the contracting authority in five copies within three months of the contract award date. The report will at minimum include data on:

- actual/estimated R&D expenses (1985-1995) as a per cent of operating revenues;
- R&D expenditures by major categories by industry, government and universities;
- changes in R&D categories in recent years and expected changes in future;
- ratios of R&D contracted out and done in-house (manufacturers and service providers);
- R&D percentage performed in Canada;
- R&D percentage qualifying as eligible R&D for income tax purposes;
- factors determining R&D expenditures;
- R&D expenditures by universities (and Centres of Excellence);
- long term versus short term R&D expenditures.

The data will be categorized by a number of variables such as province, size of firm, number of employees, ownership of firms, and research categories. The interim report will recommend mechanisms and processes for DOC to monitor Canadian telecommunications R&D in an ongoing fashion. Overall this information base will serve as the basis for the subsequent information gathering and analysis to be performed in tasks 3 through 7.

2.3.4 Task 3 - The Financial Treatment of R&D

NGL is well-versed in the analysis of R&D definitions. Some of our work has been adapted by DOC for its own needs (see Exhibit 2-2).

As noted in Exhibit 2-2, the OECD is presently reviewing the Frascati definition of R&D in light of new technology developments and requirements (e.g. software). An OECD Conference of experts is to be held in Rome, September 30th - October 4th, 1991, to prepare the revision of the Frascati Manual. NGL has followed the evolution of thinking on alternative R&D definitions and will reflect the results of the Rome Conference in its analysis. Canada's representatives at the Rome Conference will be interviewed.

The OECD Frascati definition is used for policy and statistical purposes. This definition, which is used by ISTC and Statistics Canada, differs from the narrower definition used by Revenue Canada for tax purposes (see RC Information Circular 86-4R2). Revenue Canada officials will be interviewed to determine the impact of changes in the Frascati definition, if any, on the Revenue Canada definition. As well, the views of selected industry associations, such as CATA, which have taken strong positions on R&D definitions[5] will be obtained.

The questionnaire designed for Task 2 will incorporate questions to determine how firms view current tax provisions and what changes are needed. As well, representatives of selected telecommunications carriers and equipment manufacturers will be interviewed in depth to obtain their views on the tax treatment of R&D expenditures.

2.3.5 Task 4 - The Regulatory Environment Facing Telecommunications R&D

The critical issue raised by the contracting authority in respect of its objectives is to develop appropriate policies to establish a domestic environment which will stimulate telecommunications R&D and thus improve sectoral competitive position on the one

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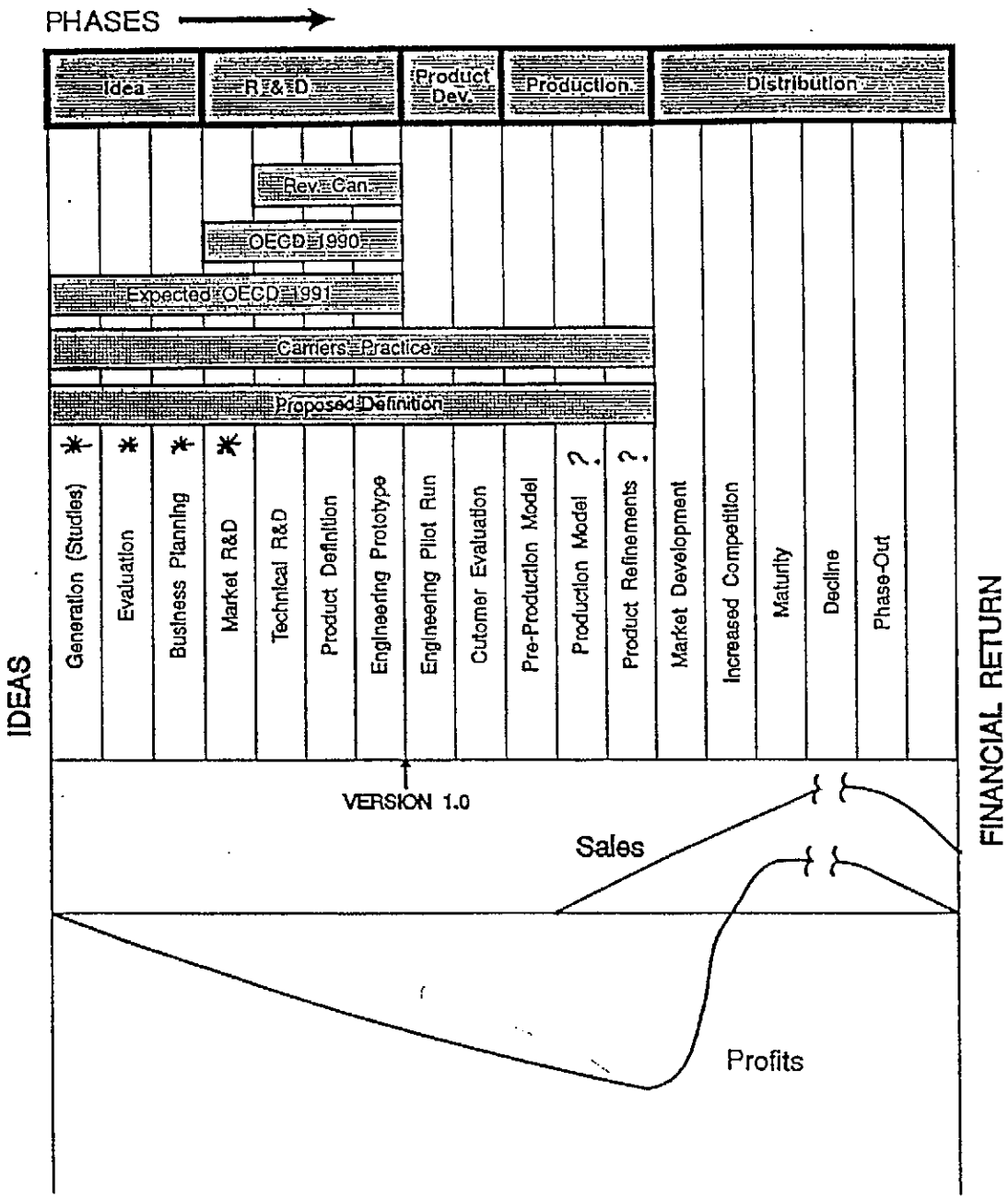
[5] CATA has organized a class action suit against Revenue Canada to enable firms to claim "common space" as an R&D expense.

Exhibit 2-2
R&D Definition



* For new products, processes or services only. These must be clearly demonstrated as being part of an overall R&D project or program.

Source: Department of Communications, Adapted from NGL's study on R&D for Cantel Inc.

hand, while ensuring that the business community has access to world class facilities and services at a fair and reasonable cost on the other.

Through previous work regarding the CRTC hearings into competition in long distance and the analysis of R&D for Cantel, NGL has developed the knowledge necessary to analyze the implications of R&D funded by the common carriers against rate bases, and subsequent implications on the user community. Described in more detail in the next section, NGL also has the advantage of information sources for comparing Canada's regulatory environment against those in other countries in order to determine whether a fair playing field exists for both the fostering of telecommunications R&D and for users to utilize telecommunications as a strategic resource.

The tendency in many industrialised countries towards more competition in the provision of services has certain effects on R&D. For example, it will be necessary to examine what has happened in the U.S. since the breakup of AT&T with respect to the levels of R&D and the nature of such R&D.

The ability to meet the objective of DOC and ISTC to increase Canada's competitiveness in the rapidly growing international market in telecommunications products will depend on whether policy and regulatory frameworks encourage innovation in Canada's own telecommunications infrastructure (e.g. fixed telecommunications networks, satellite networks, etc.). It will be necessary, for instance, to examine very closely relevant aspects of the Canadian environment to determine what improvements in existing definitions or policies for telecommunications R&D incentives might be made. In particular, both the Canadian domestic network and the Canadian policy/regulatory environment must be analyzed.

In order to arrive at realistic conclusions about how the regulatory environment might be improved, a number of persons from government, industry associations and agencies will be consulted. To be specific, the following entities will be approached:

- on policy and regulatory matters, we will consult with persons in DOC, ISTC, CRTC, and selected provincial counterparts. In addition, views from industry will be obtained in conjunction with task 2 interviews, and supplemented as required in this task;

- regarding the Canadian domestic network, DOC, Telecom Canada and, as required, selected members of Telecom Canada and other carriers (Teleglobe, Cantel, CellNet, Telesat, and Unitel) will be consulted;

- on matters of international comparison this task will be completed in conjunction with task 5 detailed below.

2.3.6 Task 5 - International Comparison of Telecommunications R&D

Through previous work (see references) and project team expertise, NGL has in depth knowledge of the sources of information and the issues related to international comparisons. Among the international sources that NGL has access to related to the telecommunication sector R&D expenditures are the following:

- OECD (especially the work of the Information, Computers and Communications Policy Committee)
- GATT Secretariat
- Company Annual Reports
- Consultant Reports (e.g. Northern Business Information, Arthur D. Little, Dataquest, DRI)
- NTIA report

Data from the above, and other sources, will be analyzed to determine which international comparisons are valid. Contact will be made with OECD and ISTC statisticians and analysts, who are known to us, to confirm the validity of R&D statistics.

Valid international R&D comparisons between Canada and high priority OECD countries will then be made, taking into account the regulatory, fiscal, financial, trade and institutional aspects of these countries. Questions such as R&D shares between governments, carriers and equipment manufacturers, as well as the level of R&D investment by regulated carriers will be addressed.

A rationale for determining Canada's telecommunications R&D expenditures appropriate to build a competitive industry will be developed. As can be appreciated from Exhibit 2-3 there appears to be threshold levels associated with sales growth as a function of R&D expenditures in the Canadian telecommunications services industry[6] which will have to be taken into account in the development of the rationale for an appropriate level of R&D expenditures.

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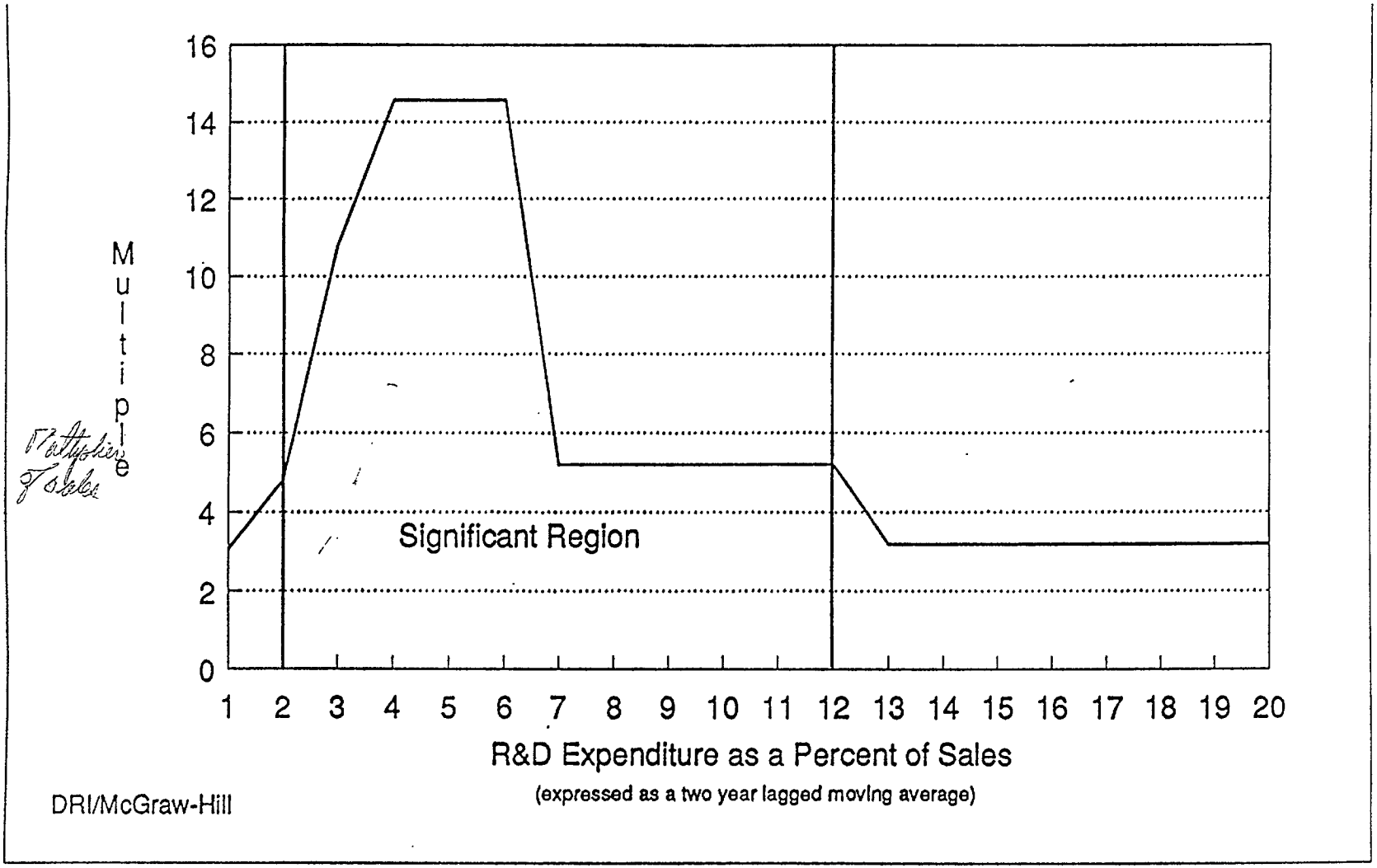
[6] DRI Canada, "An Examination of Research and Development Expenditures - Phase III," Prepared for the Science Council of Canada, July 1990.

Exhibit 2-3
High R&D Firms by Level of R&D
for the Telecommunications Industry[1]



Note: (1) Québec-Téléphone, Bell Canada, B.C. Tel, Teleglobe Inc. and Rogers Communications Inc.

- Study done for Science Council by DRI - carriers

RV interesting to look at other countries & validity of this chart

2.4 Activity III: Strategic Analysis of Telecommunications R&D In Canada

This subsection is composed of two tasks which focus on the analysis of the contracting authority's objectives and issues. These tasks analyze models for maximizing R&D effectiveness and examine the implications of increased telecommunications R&D. Details of tasks 6 and 7 are presented below.

2.4.1 Task 6 - Models For Maximizing R&D Effectiveness

In previous assignments, NGL has explored a variety of models designed to encourage R&D investment and to increase the effectiveness of investment in R&D. Effective models must enable Canadian organizations to capture the benefits of R&D. In our assignment with the Implementation Working Group of VISION 2000, we explored the factors which influence R&D effectiveness which included a review of previous work on both intra-industry R&D spill-overs[7] and inter-industry R&D spill-overs[8]. This economic impact model developed by NGL is presented in Exhibit 2-4. Given the existence of spill-overs, it is reasonable to expect that vertically integrated organizations such as Bell Canada/Northern Telecom will tend to invest more in R&D. Among the major issues that must be addressed are the following:

- developing policies which create an environment that stimulates investment in R&D and supports the effective commercialization of R&D results;
- comparing the quantity, form and effectiveness of funding support available to Canadian organizations to the support available to organizations in other countries;
- evaluating the capability of procurement policies to stimulate increased R&D activity;
- exploring the effectiveness of various collaborative R&D programs and alliance building initiatives, both in Canada and other jurisdictions, with the goal of assessing their ability to encourage increased R&D investment and to improve the effectiveness of R&D investment;

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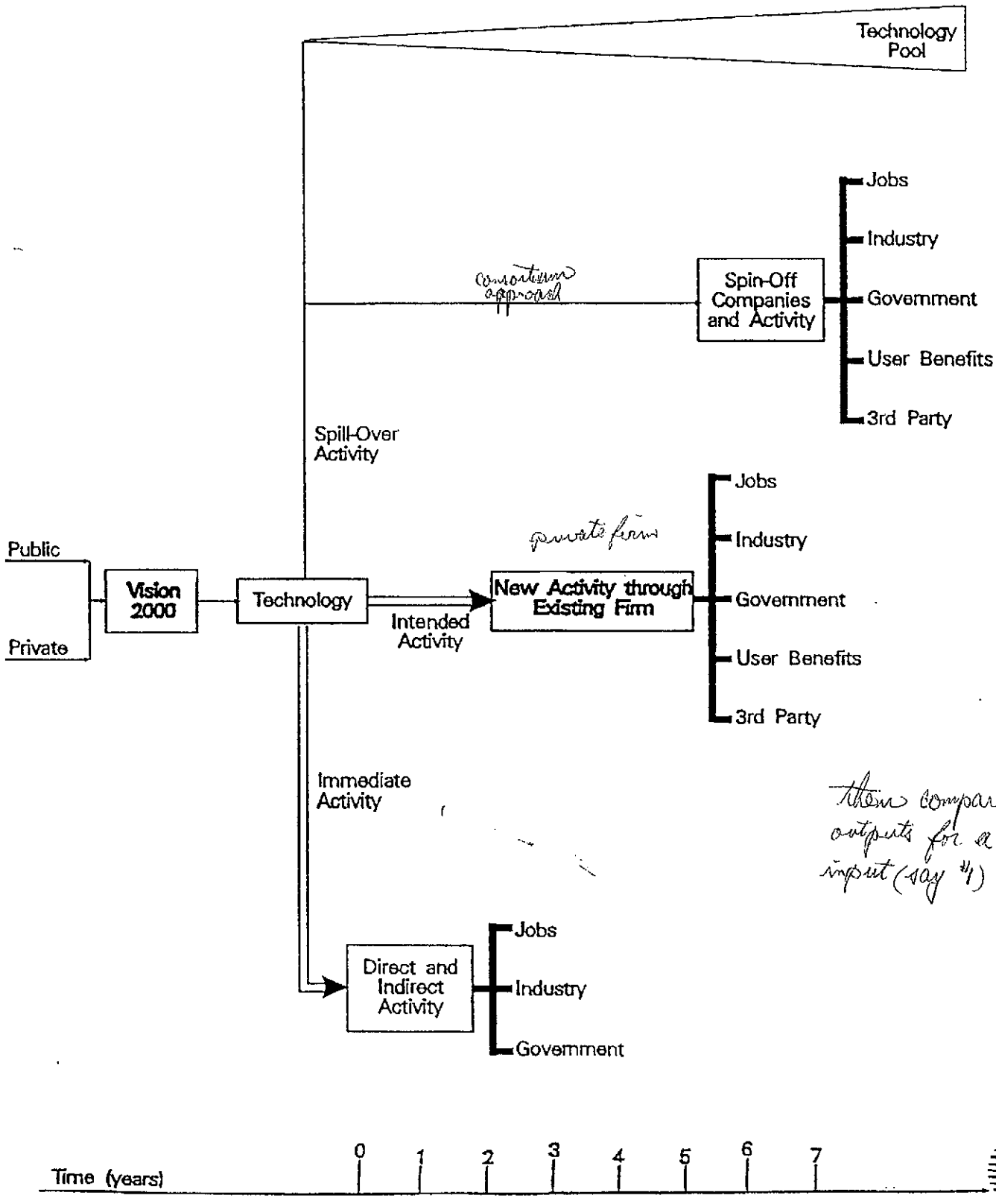
[7] Jeffery Bernstein, "Research and Development and Intra-Industry Spill-Overs, An Empirical Application of Dynamic Duality," 1985.

[8] Jeffery Bernstein, "Inter-Industry R&D Spill-Overs, Private and Social Rates of Return to R&D Capital," 1987.

Exhibit 2-4
The Vision 2000 Economic Impact Model



- the reservations placed on public support of telecommunications R&D by international trade agreements (e.g. GATT, FTA).

Collaborative R&D programs and alliance building could improve the capability of Canadian firms to finance R&D activity and to capture the benefits of the R&D investment. Collaborative initiatives, such as VISION 2000 and the Centres of Excellence, could facilitate the aggregation of R&D resources and could also enhance the diffusion of R&D findings.

The information required to develop alternative models will be drawn from a number of sources. The information collected in Task 2 will be analyzed to identify the current barriers to increased R&D investment and effectiveness. In addition, the effectiveness of other collaborative initiatives, such as the RACE and EUREKA projects, will be reviewed with a view to their applicability to the Canadian environment. Finally, the study team will consult with a number of research specialists, from both private and public sector organizations, to collect their views on the development of appropriate R&D models for the Canadian environment.

2.4.2 Task 7 - Implications Of Increased Telecommunications R&D

The analysis undertaken in the previous six tasks will be the basis of the analysis to be undertaken in this task. The material developed will provide the substantiation of an opinion on the relation between a policy which encourages R&D and the competitiveness of the sector.

There are many views of what constitutes competitiveness. The World Economic Forum uses more than 300 parameters in its comparative evaluation of the competitiveness of countries. To Michael Porter of Harvard University, who is presently leading a study on Canada's competitiveness for Business Council on National Issues (BCNI) and ISTC, productivity is the basis of the international competitiveness of a nation. A recently published Discussion Paper by the federal government[9] presents five building blocks as the basis of competitiveness (i.e. learning, science and technology, financing investment, competitive domestic market, trade). Those various definitions will be reviewed to determine the most useful with the context of the study so that questions related to appropriate levels of R&D can be properly addressed.

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[9] Government of Canada, "Prosperity through Competitiveness," Draft Discussion Paper, August 1991.

For this task, the study team will be augmented by another person, Mr. Denzil Doyle who has had long experience in examining the linkages between R&D, company growth, market share, profitability, production and innovation. He has developed models and approaches to evaluate the pay-off from R&D.[10]

A specific issue which will be addressed in the task is the treatment of R&D performed by the regulated carriers. In a recent decision, the CRTC declined BCTel's request to include increased R&D in the rate structure. As this example illustrates simply increasing the level of R&D investment may not always be acceptable. Accordingly, the study team will address specific issues that regulated carriers must face including:

- the strategic value of investing in core and ancillary activities;
- the potential to use participation in cooperative initiatives to leverage R&D investment; and
- potential regulatory incentives and/or restrictions to the type and quantity of R&D investment.

As well, the CTAC strategy, developed by NGL, will be reviewed to incorporate carrier R&D options as well as those of the manufacturers.

2.5 Activity IV: Final Project Reporting

The summation of the above activities and tasks will be prepared into a comprehensive draft report which will be submitted to the Project Authority in five copies three weeks before the end of the contract. It is proposed that this draft report will be finalized in the last week of the contract after feedback and comments from the Project Authority are received.

The final report will contain an executive summary in English and French and will be submitted in thirty copies to the Project Authority. The report will cover the topics specified under the RFP, namely:

- a comprehensive database on the state of telecommunications R&D in Canada (including an overview and detailed appendix);

[10] See for example, Doyletech, "The Communications Research Centre - Its contribution to the Canadian economy during the past 25 years, and some recommendations for the future," prepared for DOC, November 1987.

- an analysis of how Canada's situation compares to selected countries (using a common definition of R&D);
- an analysis of the managerial, institutional, regulatory and financial environment in Canada for telecommunications R&D;
- an analysis of organizational models which maximize the effectiveness of R&D resources;
- a presentation of options to encourage appropriate levels and mechanisms for Canadian telecommunications R&D by carriers, equipment manufacturers, universities and governments; and
- a comparative analysis and discussion of the relation between policies for R&D against the impact of other factors and overall affect on sector competitiveness.

The options and policy recommendations presented in the final report will serve to strengthen the sector's competitive position and balance of trade, not only in the telecommunications sector but also in all other industrial sectors through the utilization of telecommunications as a strategic resource in order to meet the challenges of globalization and international competition.

As part of our final reporting we would propose to make a presentation of our analysis and recommendations to DOC and ISTC.

MANAGERIAL PROPOSAL

3.0 QUALIFICATIONS OF THE FIRM

NGL Consulting Ltd. is a Canadian-owned management consulting firm specializing in business analysis in the communications industry. NGL personnel are well placed to carry out the project, having conducted numerous studies that are relevant to all major aspects of the present study. Major areas of expertise include:

- strategic planning ;
- the situation and issues facing industrial and telecommunications R&D and innovation in Canada;
- the telecommunications industry (manufacturers and service providers) in Canada;
- domestic and international telecommunications market analyses;
- industrial and economic competitiveness of Canada with respect to other countries;
- technology assessment;
- support for Canadian equipment manufacturers;
- studies of the telecommunications services environment.

The following examples of previous assignments best indicate NGL's capabilities for undertaking the current project:

R&D and Innovation In Canada

- Cantel's R&D Program: NGL Consulting Ltd. undertook two projects to examine Cantel's R&D program. The first study involved a comparison of Cantel's R&D activities to that of other carriers, an assessment of the definition of R&D used by Cantel relative to the Revenue Canada, OECD and carrier-implied definitions and recommendation on how to proceed in discussions with the Department of Communications. This study led to an innovative model for portraying R&D definitions on the innovation chain. The second study involved mapping each of Cantel's R&D activities on the R&D definition model. Required input was gathered through in depth interviews with Cantel R&D project managers.

- Overcoming Legislative, Administrative, Financial and Regulatory Barriers to Industrialize Innovation in Canada: NGL Consulting Ltd. undertook a study for the Prime Minister's National Advisory Board on Science and Technology to address key issues pertaining to Canada's difficulty in creating technology corporations which can compete effectively in world markets. The study included a recommended strategy for action by industry and government to overcome the impediments.

- Vision 2000 Implementation Program: NGL Consulting Ltd. undertook a study for VISION 2000 which involved (1) the development of a socio-economic impact model for the proposed R&D activities and (2) a review of possible sources of funding for the VISION 2000 program.

- Canadian Network for the Advancement of Research, Industry and Education (CANARIE) Executive Business Plan: NGL Consulting Ltd. has been retained by GTA to prepare an executive business plan to provide general direction to the Business Plan/Implementation Plan, Governance, Network Architecture and Marketing Working Groups of Project CANARIE. The plan will also be used by the CANARIE Executive Committee in conjunction with ISTC and GTA to promote the concept of a high speed network.

  Project CANARIE is to be a federal, provincial, territorial collaborative initiative with industry and the academic community to provide a national high speed communications network to accelerate the development and deployment of next generation technologies and to support collaborative R&D and education.

- Medical Devices Sector Initiative: NGL undertook a major study of technology transfer processes in the Canadian medical devices sector for ISTC. Base-line data on research activities at Canadian universities was also developed. Key research capabilities were identified.

- Discussion Paper on Financing Innovation in Multinationals Enterprises (MNEs): In this project, a discussion paper was prepared for the Science Council of Canada as background to a workshop on issues related to financing of innovation in Canada. The paper focused on the decision-making process that MNEs go through to finance their R&D and related activities and associated difficulties. Recommendations to improve the situation were made.

Strategic Planning

- A Proposal Towards A Strategic Plan for the Canadian Telecommunications Equipment Industry: for ISTC and the Canadian Telecommunications Action Committee, NGL prepared a two-part report to be used as a strategy for the Canadian telecommunications equipment industry and to promote effective industry-government consultation and cooperation. Part I consisted of a profile of the Canadian telecommunications industry in a global context, and Part II a strategic plan for the industry.

- Business Plan for SHARP: For an Ontario consortium consisting of Cantel, Ontario Hydro, University of Toronto Institute for Aerospace Studies, and the Ontario Ministry of Culture and Communications, a business plan was prepared describing how the federally-developed SHARP (Stationary High Altitude Relay Platform) technology could be commercialized as a new telecommunications/space facility. The new company was proposed to deploy SHARP systems to provide regional telecommunications services to the Canadian market. A subsidiary company would sell SHARP systems internationally. The business plan consisted of a full financing, marketing, R&D, and management plan detailing the cash flow requirements and sources of financing for the proposed venture. A comprehensive presentation package was also prepared for consortium members to inform their board members and to solicit public support.

- Unitel Application for Competition in Public Switched Long Distance Telephone Service: Dr. Grandy participated with Unitel from early 1989 to spring 1991 in the development of Unitel's application to compete in the provision of public switched long distance telephone service. Dr. Grandy provided advice on network design, R&D, contribution, the independent telephone companies, the competitive situation in other countries, etc.

- Unitel Communications Evidence: NGL assisted in preparation for the cross-examination of Unitel's witnesses in support of Unitel's long distance telephone application. NGL examined the evidence relating to the proposed network, R&D program, convergence, and international perspective on the future of telecommunications. The process included the development of detailed questions on the evidence, mock cross-examination of the witnesses and suggesting proposed responses.

- The Semiconductor Industry: Canadian Prospects: NGL was retained by the Science Council of Canada to undertake a study of the state of the

Canadian semiconductor industry and to propose strategic directions for that industry.

- Wireless Personal Communications Trends, Technologies and Applications: 1990-2000: This study for Telesat Canada, examined the trends in wireless personal communications and a variety of mobile and personal communications technologies. It addressed a new, emerging concept, the personal communications network (PCN), which consists essentially of all personal communications services (PCS). The study also looked at the types of service providers, service cost structures, pricing structures, as well as the Canadian regulatory environment. Conclusions were drawn on the window of opportunity for personal communications in Canada.

International Market - Opportunity and Competitive Analysis

- Europe 1992 - Strategic Partnering: Telecommunications Study - Marketing Arrangements: This study for External Affairs and International Trade Canada determined the arrangements used by selected Canadian telecommunications equipment firms to successfully penetrate the European market.

- Canada-Europe S&T Arrangements: NGL undertook a review of all major Science and Technology Arrangements that Canada's federal, provincial and municipal governments have with European countries for ISTC.

- Identification of International Technology Opportunities: NGL was retained by External Affairs and International Trade Canada to identify specific technological strengths and opportunities in some 40 countries and regions around the world that could be of interest to Canadian firms. The information is to be distributed to Canadian industry in an easily accessible form.

- Canada-Japan Technical and Industrial Cooperation: Possible Initiatives in Communications and Information Technologies: This study identified possible initiatives in the fields of telecommunications and information technology for inclusion in Department of Communication's strategic work program for Canada-Japan technical and industrial cooperation.

- Brokering International Strategic Alliances: NGL Consulting Ltd. received a contribution from External Affairs and International Trade Canada to investigate the potential for striking strategic alliances between Canadian

and European firms. This involved introducing the capabilities of specific French, German and Italian firms in the telecommunications/electronic sectors with their Canadian counterparts.

- International Comparison of Innovation Centres: NGL undertook a comparative study for the Innovation Centre for New Brunswick (ICNB) of selected Innovation Centres in Europe and the U.S. to assist in the shaping of the future directions of the ICNB.

- Electronic Materials (Phase 2): NGL was retained by Investment Canada to promote the industrial capability of 23 firms and 15 research organizations involved in electronic materials in Europe.

Trends in the Telecommunications Industry

- Changes in the Telecommunications Environment: 1991-2000: Ministry of Culture and Communications. NGL researched and presented the key trends and developments influencing the telecommunications environment over the current decade. The report included analysis of likely policy, regulatory and legislative changes, trends in industry structure and participants, technological developments, service availability and changes in service pricing. The report was intended as input to the development of a telecommunications strategy for the provision and use of telecommunications within the Ontario government.

- A Study of Competition in the Current and Future Local Distribution Networks in Canada: NGL was engaged by the Ontario Ministry of Culture and Communications to assess the current and future levels of competition between local distribution networks in Canada. A multi-disciplinary approach was used to identify network characteristics (eg. local telephone, cable programming and other networks) and key technological, market, regulatory, economic and institutional factors influencing these characteristics. Finally, the significance of various developments for the potential among local distribution networks in Canada was assessed.

- Study of Cross Impacts Between Public, Private and Shared Telecommunications Networks for the Next Decade: For the Department of Communications, NGL Consulting Ltd. conducted a study to provide a supply and demand analysis of public, private, and shared networks leading to a cross-impact analysis and a sensitivity analysis. Specifically, the tasks required for this study were: an analysis of demand by business for public, private, and shared networks to the year 2000, including technological, economic and regulatory factors affecting demand; determination of trends

influencing supply; analysis of cross-impacts; and identification and ranking of those regulatory and other telecommunications policies having the greatest impact on the use of public, private, and shared networks.

- NGL's Telecommunications Manual: NGL is currently in the process of developing a manual to provide those working in the telecommunications field with a good understanding of likely trends and developments over the decade. This manual will be sold widely.

- The Canadian Telecommunications Equipment Industry in a Global Context: Dr. T. Grandy of NGL was requested by the Ontario Ministry of Culture and Communications to participate in a Telecommunications Colloquium for senior officials of the Ontario government. In this presentation, Dr. Grandy laid out the major challenges facing the Canadian telecommunications equipment industry, primarily the objective of competing in international markets.

Database Creation and Development

- Trends in Electronic Materials Industrial & Research Activities in Canada: NGL was retained by Investment Canada to prepare profiles of Canadian firms involved in the development of electronic materials. The purpose of the activity is for NGL to promote Canadian capabilities in Europe for Investment Canada.

- Broadcast and Cable Products and Service Supplier Profile and Brochure: NGL was engaged by the Department of External Affairs and International Trade Canada to compile a database containing corporate and promotional profiles of key Canadian suppliers of exportable broadcasting and cable products and services. Some 90 Canadian companies are covered by this data base, which is used by over 80 Canadian trade counsellors around the world. External Affairs, in conjunction with Communications Canada, also commissioned NGL to prepare a profile of the Canadian broadcasting/ cable industry. This profile discusses how Canadians have met cultural and technology challenges of broadcasting; how resourceful Canadian operators, programmers, and product suppliers have been in meeting those challenges; and what Canada has to offer international markets. From this material a brochure will be designed to give foreign governments and potential clients for Canadian products and services a comprehensive overview of the Canadian broadcasting and cable industry.

- The Canadian Telecommunications Equipment Industry: The Case for Investing in Canada: In this study for Investment Canada and ISTC, NGL provided an overview of the Canadian telecommunications equipment industry and detailed profiles of some 30 companies. The study was intended for inclusion in material to attract U.S. investment and strategic alliances. The study has subsequently been extended to provide profiles of companies interested in investment and alliances with European firms.

4.0 QUALIFICATIONS OF TEAM MEMBERS

This section of the proposal presents the proposed personnel to be assigned to the study. The team consists of the following persons:

(1) Dr. Thomas B. Grandy, Partner, NGL Consulting Ltd. (Project Manager)
(2) Dr. Denzil Doyle, President, Doyletech Corporation
(3) Dr. Roger Voyer, Partner, NGL Consulting Ltd.
(4) Mr. Kevin Smith, Consultant, NGL Consulting Ltd.
(5) Mr. Les Routledge, Consultant, NGL Consulting Ltd.

4.1 Project Staffing

The following paragraphs highlight the experience of the team members to be assigned to this study. Complete curricula vitae are provided in Appendix B. The team consists of persons with extensive experience and knowledge of the Canadian and international telecommunications field in areas particularly relevant to this study. These areas include the development of R&D and innovation strategy and policy in both the public and private sectors, strategic planning for the Canadian telecommunications industry (in conjunction with CTAC), strategic planning regarding the domestic network (with Telecom Canada), working experience in the telecommunications equipment industry (at Northern Telecom, Bell-Northern Research), telecommunications service/equipment market analyses (Canada and the World), competitive analysis (both the industrial and economic competitiveness of Canadian/foreign firms and sectors), and technical knowledge of factors and trends regarding current and emerging telecommunications technologies, products and services.

Dr. Thomas Grandy, Partner, NGL Consulting Ltd. has more than 20 years of experience in research and development, policy formulation, strategic planning and management consulting in the telecommunications industry. His background includes work as a Systems Engineer in data communications network design for Bell-Northern Research. His research activities included design aspects of the Telecom Canada DATAPAC network. Dr. Grandy subsequently gained experience in communications policy development as Director of Communications for the Government of Newfoundland, reporting to the Deputy Minister. Much of this work was of a federal-provincial nature. From 1981-1984, Dr. Grandy was Director-Strategic Planning for Telecom Canada, responsible for the strategic business planning for the provision of Canada-wide telecommunications services.

Dr. Grandy is a founding partner of NGL Consulting Ltd. During the past several years, he has been involved with a number of key activities such as two Federal-Provincial-Territorial Task Forces on telecommunications pricing, and competition in public switched long distance telephone service. He also assisted the Chairman of the Private

Sector Advisory Committee on ISDN in completing his report to the federal Minister of Communications. Dr. Grandy has recently completed a project to assist the Unitel team in preparing for the current proceeding on long distance competition. In total, Dr. Grandy's prior positions with government and industry, combined with his consulting activities have provided him with a broad understanding of the technical regulatory, policy and institutional factors which shape the telecommunications industry.

Denzil Doyle, President Doyletech, has had a long experience with the development of the high technology sector in Canada. He was founding President of Digital Equipment Corporation of Canada. He has served as a technology and industry advisor to several provincial governments and to the federal government. He sits on the boards of several high-technology companies. His book Making Technology Happen is widely accepted as a seminal handbook for people interested in establishing and managing commercially viable high technology firms where R&D is an essential component of achieve international competitiveness.

Roger Voyer, NGL Partner, has more than 25 years of experience in the development of science and technology policies and strategic in both the private and public sectors. As Director-General, Industry and Trade, Ministry of State for Science and Technology, he participated in the elaboration of the Innovation Strategy. As Research Director at the Science Council of Canada, he directed several studies dealing with the adequacy of R&D levels to stimulate high-technology sectors. He and Dr. Grandy developed the concepts related to R&D definitions illustrated in Exhibit 2-2. He was Science Counsellor at the OECD in Paris. In that capacity, he was involved with the elaboration of the Frascati Manual and he has maintained contact with the OECD staff responsible for the gathering of comparative statistics, R&D definitions and for the work on informatics and telecommunications.

Kevin E. Smith, Consultant, NGL Consulting, brings to the project team insight into the R&D environment in Canada facing both large and small organizations. Mr. Smith has participated in communications and computer system R&D projects with Allied Signal/Garrett Canada and with Gergek International. Mr. Smith is directly familiar with the international telecommunications arena through previous work as a network engineer with Northern Telecom.

Les Routledge, Consultant, NGL Consulting, has participated in several projects evaluating the Canadian R&D environment. In an assignment to VISION 2000, Mr. Routledge developed a comprehensive framework to categorize and measure the immediate, intended and indirect benefits of R&D investment on the Canadian economy. Prior to joining the firm, Mr. Routledge gained direct industry R&D experience and participated in several aspects of R&D projects including securing funding support, coordinating multi-company development projects, and executing international technology transfers.

5.0 PROJECT MANAGEMENT AND CONTROL

This section describes how the project will be managed. The first subsection presents the proposed management structure and outlines the management activities of the project director. The second subsection indicates our ability to deal with unexpected staff changes. The third subsection presents the project work plan, including the schedule of activities tasked to each individual.

5.1 Project Management

Overall direction and control will be exercised by the Project Authority designated by DOC and ISTC. As indicated, management of the study will be under Dr. Thomas Grandy, Partner, NGL Consulting Ltd. Dr. Grandy will be responsible for overall project planning, will manage the day-to-day conduct of the study and will assume full responsibility for all deliverables. He will coordinate and attend all review meetings as required by the Project Authority (expected to take place every six weeks). In addition, he will participate actively in the planning and analysis phases of the project. Exhibit 5-1 indicates the organizational flow of the project.

The NGL project management software system will be used to monitor progress on the project and keep track of professional time on a bi-weekly basis. The system provides a means of identifying problems before they become serious, particularly missed deadlines or the over consumption of time.

5.2 Provision For The Replacement Of Key Staff

It is anticipated that individuals presented will be available for all activities indicated. However, in the event of an unusual unexpected circumstance, tasks could be re-allocated within the team as expertise indicates. In this circumstance, if further assistance were required, equally talented back-up senior and research level expertise exists within our firm who would be assigned where warranted, subject to client approval.

5.3 Project Work Plan

Exhibit 5-2 presents the proposed schedule of activities. We have prepared the schedule on the basis of the due dates specified in the RFP. We have assumed that the work will commence at approximately the end of September 1991. As indicated in the description of Activity I, within two weeks of the award of contract, we would meet with the Project Authority to discuss a more detailed work schedule. Immediately following this meeting, we would incorporate any agreed changes to the Approach and Methodology and schedule into our implementation plan.

Exhibit 5-1
Project Organization Flow

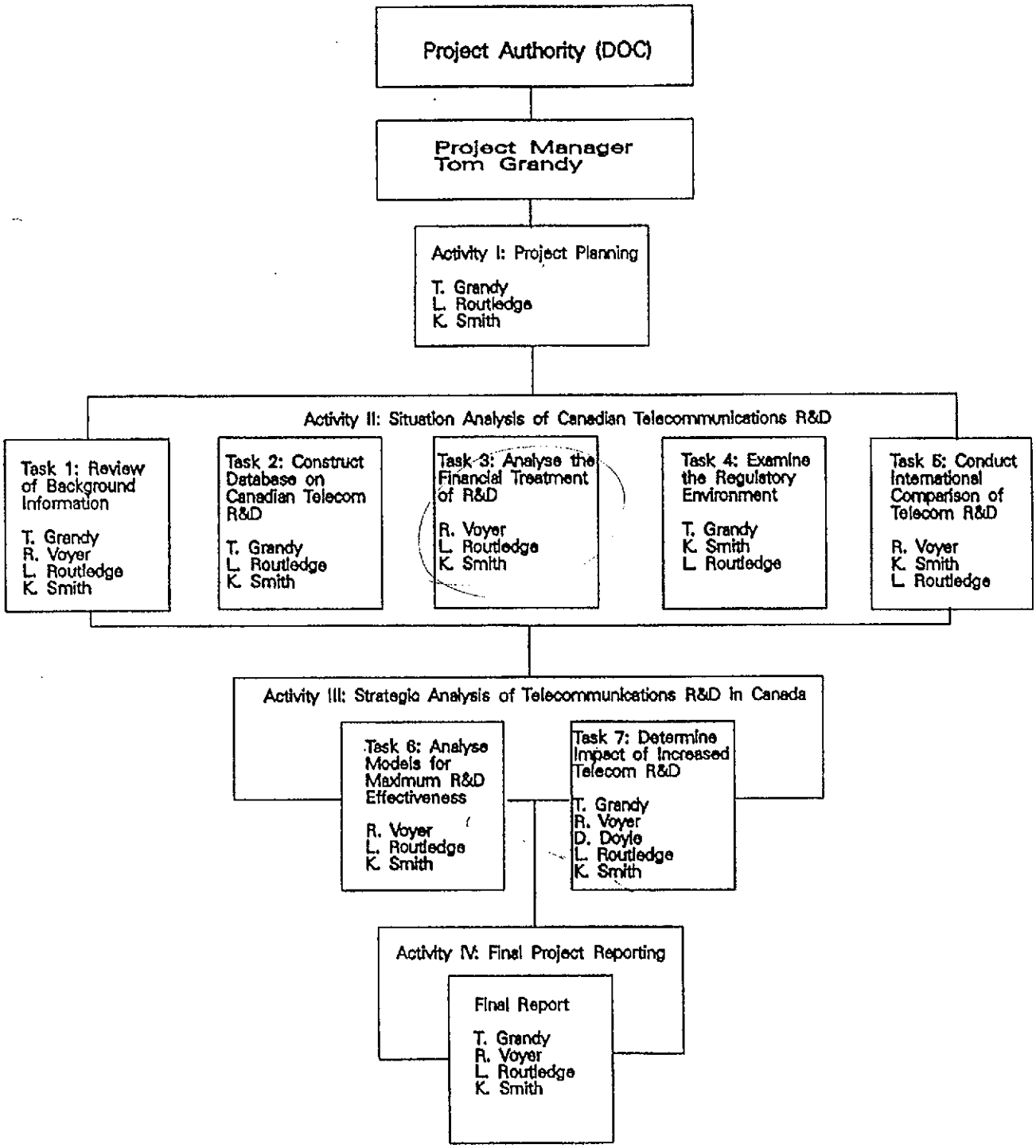

Exhibit 5-2
Project Schedule and Deliverables

Task Description	September 15	30	October 15	30	November 15	30	December 15	30	January 15	30	February 15	30	March 15	30	April 15	30
ACTIVITY I - PROJECT PLANNING																
• Award of Contract		X														
• Development of Workplan		O	--O													
• Approval of Workplan			X (Start-up		Meeting)											
ACTIVITY II - SITUATION ANALYSIS OF CANADIAN TELECOMMUNICATIONS R&D																
• Task 1 - Review of Background Information			O----------		O											
• Task 2 - Database of Canada's Telecommunications R&D																
• Determining Information Requirements			O----		O											
• Collecting Data				O----------				O								
• Compiling the Data				O----------					O							
• Activity II Report Submission									X							
• Task 3 - The Financial Treatment of R&D				O----------						O						
• Task 4 - The Regulatory Environment Facing Telecommunications R&D				O----------						O						
• Task 5 - International Comparison of Telecommunications				O----------						O						
ACTIVITY III - STRATEGIC ANALYSIS OF TELECOMMUNICATIONS R&D IN CANADA																
• Task 6 - Models for Maximizing R&D Effectiveness										O				O		
• Task 7 - Implications of Increased Telecommunications R&D										O				O		
ACTIVITY IV - FINAL PROJECT REPORTING																
• Draft Report Submission													X			
• Feedback Received from Contract Authority														X		
• Finalized Report Submitted with Executive Summary in English & French															X	
• Optional Presentation of Report Findings																X

6.0 PRICE PROPOSAL

Exhibit 6-1 provides details of professional fees and expenses. In summary, proposed fees and expenses are as follows:

Professional Fees	$ 85,525
Word Processing	1,500
Long Distance/Fax	1,000
Travel	2,000
Supplies	250
Photocopying	250
Translation	250
Total	$ 90,775

We are prepared to undertake the study for a firm price quote of $ 90,775 exclusive of G.S.T. for services detailed herein provided to the Project Authority in Ottawa, Ontario.

Exhibit 6-1
Task Allocation

TASK	TG	RV	DD	LR	KS	Total Days	Total Fees	Expenses
Activity I	1.0			1.0	1.0	3.0	$ 1,900	
Activity II Task 1	1.0	0.5		4.0	4.0	9.5	5,475	$ 3,750
Task 2	7.5		0.5	14.5	14.0	36.5	21,775	
Activity III - Task 3	2.5	1.5		4.0	2.0	9.0	5,750	
Task 4	2.0			2.0	5.5	9.5	5,550	
Task 5	4.0	5.0		8.0	11.0	28.0	17,550	
Task 6	2.0			5.0	4.0	11.0	6,450	
Task 7	0.5	2.0	3.5	1.5	4.0	11.5	7,925	
Interim Report	2.0			6.0	2.0	10.0	6,000	
Activity IV Draft Report	1.0	0.5		1.0	4.0	6.5	3,825	500
Final Report	0.5	2.5		0.5	1.0	4.5	3,325	
TOTALS	23.0	13.0	4.0	47.5	52.5	139.0	$85,525	$ 5,250
Daily Billing Rate ($)	$ 850	$ 850	$ 810	$ 550	$ 500			
Total Consulting Fees ($000)	$19,550	$10,200	$ 3,400	$26,125	$26,250		$85,525	
TOTAL EXPENSES								$ 5,250
TOTAL FIRM PRICE QUOTE							$ 90,775	

⇒ open to a different distribution of resources within price cap

APPENDIX A

RELEVANT PROJECT EXPERIENCE

Appendix A
Relevant Project Experience

The following provides a summary of key assignments that indicate NGL's capabilities in telecommunications and related technology areas:

(a) R&D and Innovation

- Development of a new approach to the definition of R&D for Cantel to meet its promise of performance on R&D to the federal Department of Communications;
- Development of an economic impact model of proposed VISION 2000 R&D;
- Development of a business plan for the Stationary High Altitude Relay Platform (a new telecommunications infrastructure concept developed by the federal Communications Research Centre), including financing, marketing, R&D and management plan detailing cash flow and sources of financing;
- Study for the Prime Minister's National Advisory Board on Science and Technology on overcoming legislative, administrative, financial and regulatory barriers to industrialize innovation in Canada;
- Study for Industry, Science and Technology Canada of the technology transfer process in the Canadian medical devices sector;
- Study for the Science Council of Canada on financing innovation in multinational enterprises in Canada.

(b) Trends in the telecommunications industry

- An analysis of changes in the telecommunications environment to the year 2000 as input to a strategic planning exercise on the procurement of telecommunications services by the Government of Ontario;
- A study of competition in the current and future local distribution networks in Canada;
- An analysis of wireless personal communications trends, technologies and applications: 1990-2000;

- An overview of the telecommunications industry and issues as input to a strategic plan for a private sector telecommunications company;

- A cross impacts analysis between public, private and shared telecommunications networks to the year 2000, including technological, economic and regulatory factors affecting demand, trends influencing supply, and identification of policy and regulatory factors having the greatest impact on these networks.

(c) Business development and strategic planning

- Development, under the direction of the Government Telecommunications Agency, of an Executive Business Plan for the Canadian Network for Advancement of Research, Industry and Education;

- Assistance to Industry, Science and Technology Canada with initial planning for the development of an implementation plan for the Canadian Network for Advancement of Research, Industry and Education;

- Assistance to Unitel Communications Inc. in business planning leading up to the current application to compete in public switched long distance telephone service;

- Assistance to Unitel Communications Inc. in a critical examination of part of its evidence;

- Preparation of a strategic plan for the Canadian telecommunications equipment industry to enable substantially increased production;

- A study of mobile data pricing for the Cantel Mobitex network and development of demand estimates for public mobile data terminals;

- An overview of alternative business strategies which could be adopted by the telephone industry with respect to the future provision of broadband-ISDN services;

- Development of strategic plans for the Canadian broadcasting and cable television industries;

- Development of a long-range telecommunications network plan for a major government organization, including nation-wide voice, data and image communications as well as local building communications.

(d) Policy and regulatory analysis

- Provision of professional services to a Federal-Provincial-Territorial Task Force on Competition in Public Switched Long Distance Service in Canada, with responsibility to co-ordinate, organize and draft the report of the Task Force, including extensive analysis of competition in the United States, United Kingdom and Japan;
- Provision of professional services to a Federal-Provincial-Territorial Task Force on Telecommunications Pricing;
- Assistance to the Chairman of a Private Sector Advisory Committee on ISDN in writing and editing his report to the federal Minister of Communications;
- Assessment of the deregulated policy and regulatory environment in New Zealand;
- Analysis of the impact of long distance competition on the independent telephone companies in Ontario and Quebec;
- Independent analysis and mock cross-examination of portions of Unitel's evidence pertaining to its long distance application;
- Input to a study of Canadian Cable Television marketing, regulatory and tariff issues, focusing on fibre optic cabling, cable industry profitability, tier marketing and negative option marketing.

(e) Technology assessment and telecommunications market analysis

- Preliminary viability and socio-economic benefit assessment of a satellite system providing a mixture of mobile and fixed services operating in the Ka-Band;
- Determination of the potential requirements for datacasting services in Canada;
- Studies of the personal communications market in Canada;
- Market surveys for Unitel of business and residential users of long distance telephone services;

- Identification of potential business opportunities in trunked mobile radio in Canada, including 800 MHz trunked mobile radio growth, complementary and competing technologies and services and potential competitors;

- Assessment, for a major U.S. paging firm, of the interest of Canadian paging companies in establishing a North American paging system and identification of the governmental issues affecting establishment of a transborder satellite paging system;

- Development of a socio-economic model of R&D activities to be undertaken by Vision 2000 in personal communications;

- Various satellite studies relating to satellite service markets, satellite applications and the technical and market aspects of Very Small Aperture Terminals (VSATs);

- Study of the market for the sharing and resale of telecommunications services in Canada;

- Analysis of the opportunities and environment necessary for the creation of a integrated fibre optic cable/telecommunications delivery system;

(f) Investment and strategic alliances

- Development of a profile of the Canadian telecommunications equipment industry and detailed profiles of selected firms to promote investment and strategic alliances from the United States;

- Development of a database of promotional profiles of Canadian suppliers of exportable broadcasting and cable television products and services;

- Survey for a European client to determine interest among Canadian businesses in investing and expanding into Europe and development of a strategic plan to guide the client's promotional activities in Canada;

- Investigation of the potential for striking strategic alliances between Canadian and European firms in telecommunications and electronic materials;

- Study of possible initiatives in telecommunications and information technologies for inclusion in the federal Department of Communications'

strategic work program for Canada-Japan technical and industrial co-operation;

- Study of the issues pertaining to creating Canadian technology corporations which can compete effectively in world markets, including a strategy for action by industry and government to overcome impediments.

(g) Technology venturing

- assisting the Science Council of Canada in developing its Technology Venturing Project which included local workshops. One was held in Corner Brook, Newfoundland;

- developing a high-technology industrial development strategy for the Société de l'Aménagement de l'Outaouais, Québec;

- preparing and undertaking a technology venturing workshop project for the Ottawa-Carleton region;

- identifying opportunities for technology commercialization in government and university laboratories in New Brunswick for the Innovation Centre of New Brunswick;

- designing a technology transfer centre for the University College of Cape Breton;

- identifying technology commercialization opportunities in the area of electronic materials for the Ottawa-Carleton region.

APPENDIX B

CURRICULA VITAE OF THE PROJECT TEAM

Thomas Grandy
Partner
B.A., B.Sc., M.Sc., Ph.D.

SUMMARY OF EXPERIENCE

Dr. Grandy brings to NGL's consulting practice 20 years of experience in the academic, government and business environments. He holds a Ph.D. in physics from the University of Alberta, has conducted research in physics at the University of Montreal and the University of Kentucky and taught computer science at the University of Windsor and the University of Ottawa. Dr. Grandy has also worked as a Systems Engineer for Bell-Northern Research (data communications network design), as Director of Communications for the Government of Newfoundland (communications policy) and as Director-Strategic Planning for Telecom Canada (strategic planning for Canada-wide telecommunications services). He has been actively engaged in consulting since 1984 for a range of public and private sector clients.

As such, Dr. Grandy has had experience with pure and applied research, policy development (particularly of a federal-provincial nature), and strategic planning. He is particularly knowledgeable with the industry structure, regulatory framework, business arrangements and revenue settlement processes of the telecommunications industry in Canada. He is closely familiar with telecommunications policy concerns at both the federal and provincial levels of government.

CONSULTING EXPERIENCE

Dr. Grandy entered the consulting field in 1984 and consults primarily in the fields of telecommunications and science and technology policy, strategic planning and technology assessment. Examples of the projects in which he is currently or was recently involved include:

- A forecast of changes in the telecommunications environment to assist the Government of Ontario in provisioning its telecommunications services;
- Preparation of a profile of the Canadian telecommunications equipment industry for Investment Canada and Industry, Science and Technology Canada;
- Development of a strategic plan for the Canadian telecommunications equipment industry for Industry, Science and Technology Canada;
- Study of trends and opportunities in marine communications for the Canadian Centre for Marine Communications, including marine military communications;
- Definition of R&D in the telecommunications service sector for a private sector client;
- Assistance to Unitel Communications Inc. in business planning, network design and regulatory issues relative to applying to the CRTC for permission to provide competitive long-distance telephone service;
- Project manager for a study of the cross-impacts between public, private and shared telecommunications networks to the year 2000 for the Department of Communications;
- An analysis of the global Very Small Aperture Terminal (VSAT) market potential for a private sector client;
- Managing editor for a Federal-Provincial-Territorial-Examination of Competition in Public Long-Distance Telephone Service;

- Development of a VSAT Reference Manual for Satellite Communications;
- A multi-client study of the market for VSAT products and services throughout Canada;
- A strategic analysis of the implementation of broadband ISDN within the telecommunications industry for a private sector client;
- An analysis of telephone company versus cable distribution technologies relative to future third-party provision of teleshopping;
- A study of future satellite applications, Canadian supplier capabilities and future spacecraft requirements for the Department of Communications;
- Examination of various aspects of increasing Canadian R&D efforts;
- Development of an implementation plan for a National Technology Marketing Network;
- Managing editor and writer for a Federal/Provincial Task Force on the Pricing of Telecommunications Services and the Universal Availability of Affordable Telephone Service;
- A market analysis of opportunities related to the sharing and resale of telecommunications services;
- A study of the impact of international competition on the Canadian telecommunications industry and its users, particularly the incentives to bypass Canadian facilities;
- A study of employment in the telecommunications industry in Ontario with particular focus on job creation;
- A survey of cultural facilities across Canada to determine their physical characteristics, costs and accessibility;
- A study of the extent and incentives for international bypass of Canadian toll facilities on Canada-Canada,Canada-US and Canada-Overseas toll calls;

- A study of the commercial viability of operating a telecommunications resale service in Canada, including resale of Canada-U.S. telecommunications services at selected locations in Ontario and Quebec;

- A study to determine an Optimal Management Strategy for Optical Data Disc Technologies in the federal government.

PREVIOUS EMPLOYMENT AND RESPONSIBILITIES

Director-Strategic Planning, Telecom Canada (1981-1984)

As Director-Strategic Planning for Telecom Canada, Dr. Grandy was involved in strategic business planning for the provision of Canada-wide telecommunications services. His activities included:

- development of a General Strategic Plan for Telecom Canada detailing the major operational aspects of the provision of Canada-wide services, key issues to be resolved, current strategies and a required program of strategy development;

- development of a strategic plan regarding the regulation of Telecom Canada services;

- participation in various projects to determine the responses of Telecom Canada to increasing competition in the telecommunications industry, including bypass, rate restructuring, and sharing and resale.

Director of Communications, Government of Newfoundland (1975-1981)

As Director of Communications for the Government of Newfoundland, Dr. Grandy managed the provincial government's Communications Division, developed communications policy options, and prepared recommendations for government action on a broad range of communications issues. His activities included:

- participation on various provincial and federal-provincial committees to develop policy alternatives in areas such as competition in the telecommunications industry, delegation of cable regulation, satellites and pay television, and constitutional change;

- development of plans and programs to improve communications services within the Province;

- provision of consulting services to the Newfoundland Public Utilities Board on various aspects of inter-provincial telecommunications including revenue settlements and rates and tariffs.

Systems Engineer, Bell-Northern Research (1973-1975)

As a Systems Engineer for Bell-Northern Research, Dr. Grandy conducted research on the structure of data communications networks in Canada. His research activities included:

- A study of the location of computer intelligence in a data network;
- Determination of remote concentrator capabilities in the DATAPAC network;
- Possible DMS design considerations to accommodate data communications;
- A study to determine DATAPAC capabilities for specific telecommunications user groups, particularly user groups within the financial community.

Academic Experience (1967-1975)

Dr. Grandy has conducted research in physics at the University of Montreal and the University of Kentucky and published a number of papers in this area. He has also taught computer science at the University of Windsor and the University of Ottawa.

EDUCATION

Dr. Grandy holds a B.A. (Education) (1959), a B.Sc. (Physics) (1960), and an M.Sc. (Physics) (1962) from Memorial University of Newfoundland, and a Ph.D. (Physics) from the University of Alberta (1967).

Roger D. Voyer
Partner
B.Sc., M.Sc., D. Ing.

SUMMARY OF EXPERIENCE

Dr. Voyer, has over 25 years experience in the development and implementation of science, technology and industrial strategies in both the public and private sectors. He has a broad international experience including representing Canada on the OECD Committee on Science and Technology Policy. His consulting practice centers on providing strategic advice on technology and industrial policies to private and public sector clients.

His experience was gained through industrial research with Canadian Liquid Air Ltd. and in science and technology policy with the Science Council of Canada where he was Science Advisor and later Director of Research. Dr. Voyer was Executive Director of the Canadian Institute for Economic Policy through its 5 year mandate, and Director-General of the Industry and Trade Branch of the Ministry of State for Science and Technology.

Dr. Voyer holds B.Sc. (1961) and M.Sc. (1962) degrees in Chemical Engineering from Queen's University, Kingston and a Doctorate in solid state physics from the Université de Grenoble, France.

Selected projects which Dr. Voyer was centrally involved included:

Science/Technology and Industrial Policy

- Evaluation of corporate practice in technology-intensive firms for the Prime Minister's National Advisory Board on Science and Technology;
- Strategic planning for the Innovation Place, the research park in Saskatoon, Saskatchewan;
- Technology transfer to Mexico for Atomic Energy of Canada Ltd.;
- Industrial benefits from offshore oil and gas development for the Department of Regional Industrial Expansion;
- An evaluation of the management and organization of new federal government laboratories for the Science Council;
- Strategic Planning for the Science Institute of the Northwest Territories;
- Strategic Planning for Fathom Oceanology;
- An evaluation of a hydrogen R&D program for the Department of Energy, Mines and Resources;
- The role of the science advisor in the Department of Indian Affairs and Northern Development;
- Feasibility of an integrated energy complex in Quebec for the Department of Energy, Mines and Resources;
- A strategy for attracting high-technology firms to the Outaouais for the Societe d'Amenagement de l'Outaouais;
- Evaluation of public sector R&D in New Brunswick for the Innovation Centre of New Brunswick;
- Community-based technology development (technology venturing) for the Science Council.
- An evaluation of the factors leading to successful innovation for the National Advisory Board on Science and Technology (NABST).
- Identification of high-technology opportunities in Rhône-Alpes, France; Baden-Wuerttemberg, Germany and Lombardy, Italy.

Communications

- Analysis of opportunities in electronic materials for the Ottawa Carleton Research Institute et al;
- Development of a strategy for the Canadian Telecommunications Action Committee;
- Feasibility study of a Canadian Communications Informatics and Space R&D Institute for the Department of Communications;
- Strategic evaluation for VISION 2000;
- Secretary of the Communications Research Advisory Board (CRAB);
- Assessment of Japanese optical disk technology for the Science Council;
- Strategic importance of optical disc technology for Nexa Corp.;
- Study of artificial intelligence and machine translation for the Department of Communications and Secretary of State;
- Assessment of office communications technology for the Department of Communications;
- Assessment of personal communications R&D requirements for VISION 2000;
- Economic impact of CBC expenditures for the Canadian Broadcasting Corporation;
- Business plan development for the Stationary High Altitude Relay Platform (SHARP);
- Preparation of an investment portfolio in electronic materials, including promotion in Europe, for Investment Canada.

PUBLICATIONS

Dr. Voyer has published widely on science, technology and industrial policy matters. He authored the following books:

- Global 2000; Canada - A View of Canadian Economic Development Prospects Resources and Environment (with M. Murphy) - Pergamon Press, 1984
- Offshore Oil; Opportunities for Industrial Development and Job Creation; Lorimer Publishers, 1983
- A Technology Assessment System (with M. Gibbons), Science Council of Canada, 1974
- Wrote the Industry section of "The Canadian Encyclopedia" published in 1985; an enlarged edition was published in 1988.

DENZIL J. DOYLE
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CURRICULUM VITAE

Mr. Doyle received a B.Sc. (Honours) degree in Electrical Engineering at Queen's University in 1956 and began his career as a design engineer with Computing Devices of Canada Ltd. (1956-57), and with the Defence Research Board (1957-63). In 1963 he established a sales office for Digital Equipment Corporation in Ottawa, which by 1981 had evolved into a multi-faceted corporation with sales in excess of $160 million and employment in excess of 1,600 people. Mr. Doyle resigned as president of Digital in 1981 to pursue a career dedicated to the creation and development of a stronger high technology industry in Canada. In 1982, he formed Doyletech Corporation, a consulting firm which specializes in the planning of new business ventures and in the creation of management tools for the orderly growth of technology-intensive firms. In this capacity he has served as an advisor to several provincial governments as well as the Federal Minister of State for Science and Technology. He assisted the province of Saskatchewan to implement a comprehensive technology strategy that resulted in the creation of more than 50 firms over a four year period.

Mr. Doyle's most significant consulting assignments and achievements:

- Government of New Brunswick - implemented a new ventures strategy and established the New Brunswick Innovation Centre to assist would be entrepreneurs in drawing up business plans, doing market research and launching new firms.
- Atomic Energy of Canada Ltd. - assistance in the identification and exploitation of technology for the purpose of creating new business units.
- Fisheries Technologies Group , St. John's, Newfoundland - assessment of the market potential for technology-based products manufactured in Newfoundland for sale to the fisheries industries throughout the world.
- Instantel Inc. - Mr. Doyle founded Instantel Inc. in 1982, a firm that manufactures seismographs and a broad line of instrumentation for use in the resource industries.
- Ministry of State for Science and Technology - assisted in the formulation of policy for technology transfer out of government laboratories.
- Energy, Mines and Resources Canada - Assisted in the drafting of a new document for identifying technology exploitation opportunities.

He holds directorships with several technology corporations and has served on the National Research Council of Canada. In addition to his practical experience in engineering and corporate management, he has attended a number of training programs, seminars and conferences including the Northeastern University Management Development Program in 1970. In recognition of his pioneering efforts in the development of the Ottawa-Carleton high technology community, he received an Honorary Doctorate of Engineering from Carleton University at its 1981 spring convocation.

Kevin E. Smith
Consultant
B.A.Sc., M.B.A.

Mr. Smith recently joined NGL Consulting Ltd. after completing his M.B.A. at the University of Western Ontario (1991). This degree, combined with his Electrical Engineering Degree from the University of Waterloo (First Class Honors) as well his hands-on engineering experience give him a good appreciation of technological and business concerns.

EMPLOYMENT HISTORY:

- INTERTEC LTD.

  - Policy Consultant to the President of this Toronto 500 company
  - Developed a strategic business plan for Intertec's electronic systems division
  - Completed analysis regarding the acquisition of two competitors

- NORTHERN TELECOM CANADA LTD. D.S.D., TORONTO/MONTREAL

  Network Engineering, NTPFC & Quebec Region

  - Implementation Prime for the SC project and CCS#7
  - Team member designing telephone network for Jianxi Province, China
  - Managed the implementation of all network software applications, Canadian market
  - Strategic Marketing - ISDN Product Specialist (DMS)

  Engineering Process Council

  - Automated switch analysis process, cost savings of $200,000
  - Restructured product delivery process, cost savings of $250,000

  Customer Engineering

  - Project management of DMS telephone switching centres for Ontario market
  - Assisted Sales in providing technical consulting services to customers

- ALLIED SIGNAL: GARRETT CANADA, SPECIAL PROJECTS GROUP, REXDALE

  - Designed an ARINC 429 Communications Interface for commercial aircraft
  - Assisted in the development of an electro-impulse wing de-icing unit

- GERGEK INTERNATIONAL, TORONTO

  - Enhanced the design of the company's incremental optical encoder

- KIMBERLY-CLARK CANADA LTD., THUNDER BAY

  - Established a database for on-line control of plant inventory

- IBM CANADA LTD., TORONTO

  - Software analysis
  - Customer Service Representative

- WHITE CONSULTING LTD., VANCOUVER

  - conducted geophysical field research for the mining industry

Les Routledge
Consultant
B.Sc., M.B.A.

SPECIALTIES

Mr. Routledge's areas of expertise include the development of business plans, marketing strategies, and effective organizational structures for advanced technology companies. He is knowledgable in a broad range of business areas including strategic planning, the development of marketing policy, R&D and information system management, and marketing research techniques.

SUMMARY OF EXPERIENCE

Mr. Routledge has applied his skills in a variety of assignments at NGL including the following examples:

- Developing a comprehensive business plan, financial model and socioeconomic impact assessment related to the commercialization of the SHARP (Stationary High Altitude Relay Platform) Technology for an Ontario based consortium;

- Developing and refining an socioeconomic impact model to illustrate the qualitative and quantitative economic benefits related to increased levels of Research & Development activity in the Canadian environment;

- Developing a world sales strategy for a mobile satellite communications product for a Canadian firm; the project involved identifying potential customers and their equipment requirements, and assessing competitive products offerings;

- Developing a product introduction and market development strategy for a Canadian firm contemplating the introduction of an advanced fibre-based cable television transmission system in North America and Europe;

- Determining the current and potential requirements in Canada for datacasting (one way point-to-multipoint data transmission) services which use technologies such as teletext, FM radio sidebands, VSAT's and dedicated radio spectrum;

- Analyzing the current technological developments associated with Cable Television distribution equipment and projecting future technological trends and associated impacts on the operation of the Canadian Cable Television systems;

- Evaluating the key assumptions and the major decision-making process used by a federal government department for the acquisition of computer equipment and services;

- Compiling a database containing promotional profiles of key Canadian suppliers of exportable broadcast and cable products and services for the Department of External Affairs and International Trade Canada;

- Exploring the potential for Canadian investment in southern France by Canadian firms active in the informatics, broadcasting/cable, agri-business, tourism and medical sectors;

- Identifying economic development opportunities associated with major crown projects for a regional economic development agency.

PRIOR EXPERIENCE

Mr. Routledge's previous experience has seen him act in the capacity of a project manager, systems specialist, and customer service representative. Experience with the development and commercialization of innovative transportation information technology systems, such as automatic truck inspection stations provides Mr. Routledge with insight into the hurdles facing the introduction of new technologies.

In his previous position of Systems Specialist with International Road Dynamics, a systems integration company serving the transportation industry, Mr. Routledge participated in several projects involving the introduction of new technologies including:

- *Development and demonstration of a low cost Weigh-in-Motion scale systems for highway applications*, a research project jointly sponsored by the Transportation Development Centre and the Ministry of Transportation of Ontario which involved the transfer of advanced piezo-electric sensor technology from a French government agency and adapting it to suit Canadian environmental and market requirements;

- The design, development and demonstration of a Weigh-in-Motion system which included the development of sensor interface systems, real-time software algorithms and data collection programs for the State of Oregon;

- The development, demonstration, and market launch of a family of advanced traffic monitoring systems that possessed a range of capabilities to meet the individual needs of for rural, regions, urban and provincial traffic agencies;

- The design, construction and commissioning of several weigh-in-motion systems with the capability to automatically detect a vehicle in violation of weight & height restrictions and then direct it's operator to report to a Truck Inspection Officer.

EDUCATION

By combining the knowledge and skills gained from his MBA and Electrical Engineering degrees, Mr. Routledge can appreciate both technological and business concerns. This appreciation contributes to the balanced perspective that Mr. Routledge brings to bear on his assignments.

Mr. Routledge holds an **MBA degree from the University of Western Ontario.** The topics of his courses included business planning, marketing policy development, marketing research, R&D policy development, and information technology management. This broad mix of subject areas has exposed Mr. Routledge to issues ranging from strategic planning and technological evolution to effective marketing research techniques.

Mr Routledge completed his **B.Sc. (EE) at the University of Manitoba.** The topics of his courses included communications systems and engineering management.

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