National Science and Technology Policy Forum

Winnipeg, Manitoba
June 8, 9 & 10, 1986

Conférence nationale sur la politique scientifique et technologique

Winnipeg, Manitoba
les 8, 9 et 10 juin 1986

Minister of State
for Science and Technology

Ministre d'État chargé
des Sciences et de la Technologie

The Honorable L'honorable
Frank Oberle

Science Council of Canada

Conseil des sciences du Canada

Stuart L. Smith

CANADIAN FORUM on a NATIONAL SCIENCE and TECHNOLOGY POLICY
projected attendance

INDUSTRY and BUSINESS		72
Resource Sector	13	
Manufacturing- medium technology	11	
High Technology	24	
Service Sector	20	
Business associations- general	4	
THINK TANKS		4
ACADEMICS		54
PROFESSIONAL ASSOCIATIONS		10
LABOUR		27
CLC and affiliates	25	
CFL and CNTU	2	
MINISTERS AND SENIOR OFFICIALS (estimated)		20
PARLIAMENTARIANS		8
FEDERAL CROWN AGENCIES		6
FEDERAL AND PROVINCIAL OFFICIALS		10
YOUTH		4
OTHER PARTICIPANTS		7
MINISTERS' STAFF (estimated)		*10*
FEDERAL AND PROVINCIAL OBSERVERS (estimated)		*20*
MOSST AND SCC STAFF (estimated)		*16*
TECHNICAL AND CLERICAL SUPPORT (estimated)		*20*
PRESS (estimated)		*15*

PARTICIPANTS: 222 TOTAL PRESENT: 303

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NATIONAL SCIENCE AND TECHNOLOGY POLICY FORUM

NATIONAL SCIENCE AND TECHNOLOGY POLICY FORUM

Winnipeg, June 8-10, 1986

AGENDA

June 8

1500 - 2100 Registration, Lobby of the Fort Garry Hotel

1900 - 2100 Reception, hosted by federal, provincial and territorial Ministers, to be held at the Canadian Institute of Industrial Technology. Shuttle bus available from Fort Garry Hotel.

June 9

0800 - 1000 Registration - 7th floor, Fort Garry Hotel

0900 - 0915 Opening of the Forum: Concert Hall - 7th Floor, Fort Garry Hotel
Dr. Stuart Smith, Science Council of Canada, Forum Chairman.
Welcome by:
The Honourable Victor Schroeder, Minister of Industry, Trade and Technology, Province of Manitoba

0915 - 0945 Opening Address: "The Task of the Canadian Forum on a National Science and Technology Policy"
The Honourable Frank Oberle, Minister of State for Science and Technology, Canada

0945 - 1015 Bus transportation from the Fort Garry Hotel to the nearby Winnipeg Convention Centre; coffee, tea and juices available at the Centre, in or near the workshops.

At this point, the Forum will divide into six workshops, two on each of three themes. The workshops will be located on the main floor of the Convention Centre. Each workshop will have a resource person, a moderator, a rapporteur, and approximately 30 participants. Each participant will be assigned to workshops on all three themes and three workshops with simultaneous translation will be available in each of the three rounds, one workshop for each theme.

Workshop Topic A: "The Development and Acquisition of New Knowledge"

Workshop Topic B: "Putting Knowledge to Work and Realizing Opportunities"

Workshop Topic C: "Involving All Canadians and Adapting to Change"

1015 - 1200 First round of workshops.

1215 - 1345 Luncheon in Meeting Room #4 of the Winnipeg Convention Centre. The guest speaker will be the Honourable Howard Pawley, Premier of the Province of Manitoba.

1345 - 1530 Second round of workshops.

1530 - 1545 Break for coffee, tea and juices.

1545 - 1730 Third round of workshops.

1730 - 1800 Return bus service to the Fort Garry Hotel

1830 - 2100 Reception and dinner on the 7th floor of the Fort Garry Hotel, hosted by the Honourable Frank Oberle. The after dinner speaker will be Dr. J. Fraser Mustard.

10 June

0730 Written reports on the outcomes of the proceeding day's workshop sessions will be available for pickup at the Conference Secretariat desk on the 7th floor of the Fort Garry Hotel.

0900 - 1030 Plenary Session, in the 7th floor, Concert Hall, chaired by Dr. Stuart Smith, "A National Science and Technology Policy: A Look at Canada's Future".

There will be a fairly brief presentation of workshop findings, after which spokespersons from each of the sectors - university, industry and labour - will provide their comments.

1030 - 1045 Break for coffee, tea, and juices.

1045 - 1230 Plenary Session continues with further discussion of issues.

1230 - 1300 Summary statement by Dr. Stuart Smith. Closing remarks by the Honourable Frank Oberle.

Forum is adjourned

FACT SHEET

National Science and Technology
Policy Forum - Winnipeg, June 8-10

Registration

Registration will be held from 15:00 to 21:00 hours on Sunday, June 8, in the lobby of the Fort Garry Hotel.

Registration on Monday morning, June 9, will be from 8:00 to 10:00, on the 7th floor of the Fort Garry Hotel, outside the Concert Hall Room.

All persons registering will receive a binder containing the following: list of participants; final agenda; the revised background paper; and copies of briefs on science and technology policy which Minister Oberle has requested from business, labour and professional associations invited to the Forum. Each person will receive a name tag, and formal invitations from the Minister to the reception on June 8 and to the reception and dinner on June 9. Participants will be informed about which workshops to attend.

Participants, observers, staff and press should wear their identifications badges at all times so as to facilitate their access to the plenary sessions, workshops, receptions and meals.

Reception - June 8

A reception will be held at the Canadian Institute of Industrial Technology, 435 Ellice Street, Winnipeg, from 19:00 to 21:00. A shuttle bus service will be available between the Fort Garry Hotel and the Institute. Drinks will be provided along with light snacks.

Breakfast

A buffet breakfast will be available for all in the Crystal Ballroom from 7:00 to 8:30 on June 9 and 10.

Opening Session

The opening session starting at 9:00 will be held in the Concert Hall on the 7th floor of the Fort Garry Hotel. Following this, coffee will be served at the Winnipeg Convention Centre, in or about the main floor workshop rooms. Bus service will be available from the Fort Garry Hotel to the nearby Convention Centre in the morning, and for the return trip in the late afternoon.

Workshops

For the workshops at the Winnipeg Convention Centre, six fairly large rooms have been reserved. Three of the six workshops in session at any time will have simultaneous French-English translation (one for each theme).

Luncheon - June 9

Luncheon at the Convention Centre will be hosted by the Province of Manitoba, with the Honourable Howard Pawley, Premier, as the guest speaker. All are invited to attend.

Reception and Dinner - June 9

A reception and dinner will be hosted by the Honourable Frank Oberle. The reception will be from 18:30 to 19:30 in the foyer on the 7th floor of the Fort Garry Hotel. Dinner will be served at 19:30 in the Crystal Ballroom on the same floor.

Forum Services

An information desk will be set up for the duration of the Forum in the 7th floor hotel loggia. As well, there will be a second information desk open at the Winnipeg Convention Centre from 10:00 to 17:30 during the workshops. Participants may be contacted through the following telephone numbers: (204) 949-6956 at the Fort Garry Hotel; and (204) 949-6336, at the Convention Centre, and runners will be available to deliver messages.

The Forum secretariat, to be set up in the 7th floor hotel loggia, will have a photocopier, a word processor and a telecopier. Translation services will be available for written documents and there will be several telephones for outside calls.

Media

The media have been invited to all sessions, workshops and social events, and will have access to all documents. A media room will be set up on the 7th floor of the Fort Garry Hotel.

830-220-002

NATIONAL SCIENCE AND TECHNOLOGY FORUM

Notes on Meeting Arrangements

June 8-10, 1986
Winnipeg, Manitoba

Canadian Intergovernmental Conference Secretariat • Secrétariat des conférences intergouvernementales canadiennes

NATIONAL SCIENCE AND TECHNOLOGY FORUM

June 8-10, 1986
Winnipeg

NOTES ON MEETING ARRANGEMENTS

1. Secretariat Services

a) Secretariat services will be available as follows:

June 8: 15:00 - 21:00 hours

June 9: 7:30 - 22:00 hours

June 10: 7:30 - 17:00 hours

b) The Secretariat will have a main office in the Loggia on the 7th floor of the Hotel Fort Garry to coordinate such services as typing, printing, distribution of documents, admission passes, handling of messages, interpretation and translation, etc. As well, there will be several toll-denied telephones in the secretariat for delegates use. To call long distance delegates should use a calling card or go through the operator.

During the workshops on June 9, a supplementary secretariat office will be set-up from 10:00 to 17:30 hours in room MR 17 at the Winnipeg Convention Centre.

c) Delegates and observers are asked to have incoming telephone calls made on the Secretariat telephone number (204) 949-6956 in order to have messages taken and posted at the message board. Messages for Ministers will be delivered in person, if possible.

During the workshops on June 9, an additional number, (204) 949-6336, will be available for messages at the workshop site.

d) All requests for the above services should be addressed to the Conference Secretary, ERIC BURKLE, or the Secretariat Coordinators, CAROL BOURGEOIS and CATHY DERMODY. Secretariat services are available to all delegates. All support staff will wear badges with a black circle. Please ask them if you need any assistance.

2. Forum Documents

There is no access restriction to any of the forum documents. All documents are public unless otherwise requested by the originator.

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3. Document Distribution

a) During the Meeting

The CICS will provide a document distribution service during the meeting. In order to obtain this service, delegations should forward all requests to the Secretariat Office. No documents will be released without appropriate written authorization from the originator.

The CICS will also prepare and distribute a final list of delegates and observers and distribute same on Tuesday morning, June 10.

b) After the Meeting

After the meeting, the Secretariat will prepare a list of documents tabled. Copies of the listed documents will be available upon request.

4. Taped Record of Proceedings

The forum plenary sessions and the workshops will be taped. The taped record of these proceedings will be held by the Canadian Intergovernmental Conference Secretariat (CICS) and, with the approval of the Chairman, will be available on loan to delegations.

A verbatim transcript of the forum opening and plenary sessions will be prepared for the Science Council of Canada and the Ministry of State for Science and Technology. Copies will be available from the CICS on a request basis, subject to the approval of the Chairman.

5. Simultaneous Interpretation

Simultaneous interpretation in French and English will be provided for the plenary sessions in the Concert Hall at the hotel, and in rooms MR 5, MR 7/8, and MR 10/11 at the Convention Centre.

6. Access to the Meeting Rooms

The forum sessions will be open to invited delegates and observers and the media. Admission to the sessions will be controlled by the use of identification badges issued by the CICS. They should be worn at all times so as to facilitate access to the plenary sessions, workshops, receptions and meals.

7. Media Services

A media room will be available on the 7th floor of the Hotel Fort Garry and will be staffed by two media relations officers. The

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telephone number for the media room is (204) 949-4166. The Secretariat can put you in touch with the media coordinators who will assist with arrangements for radio and television interviews and press conferences. Accredited media will have access to all forum sessions, including the workshops.

8. Transportation

Bus services will be available to and from the reception at the Science Centre on June 8 and to and from the Winnipeg Convention Centre on June 9. Details will be announced at the respective meetings.

CICS Mailing Address:
P.O. Box 488
Station "A"
Ottawa, Ontario
K1N 8V5

CICS Office Address:
110 O'Connor Street
10th Floor
Ottawa, Ontario

Telecopier (613) 996-6091
Telex 053-4435
Telephone number: (613) 995-2341

830-220-003

NATIONAL SCIENCE AND TECHNOLOGY POLICY FORUM

CONFÉRENCE NATIONALE SUR LA POLITIQUE SCIENTIFIQUE ET TECHNOLOGIQUE

Expected List of Delegates and Observers

Liste préliminaire des délégués et observateurs

June 8-10, 1986
Winnipeg, Manitoba

le 8-10 juin 1986
Winnipeg (Manitoba)

Canadian Intergovernmental Conference Secretariat • Secrétariat des conférences intergouvernementales canadiennes

NOTE

Please report to the Secretariat any inaccuracies that may appear in this list

NOTA

Nous vous prions de signaler au Secrétariat toute erreur que peut comporter cette liste.

NATIONAL SCIENCE AND TECHNOLOGY POLICY FORUM

CONFÉRENCE NATIONALE SUR LA POLITIQUE
SCIENTIFIQUE ET TECHNOLOGIQUE

June 9 & 10, 1986 Les 9 et 10 juin 1986

WINNIPEG

List of Delegates & Observers
Liste des délégués et observateurs

Stuart L. Smith
Chairman
Science Council of Canada

The Hon. Frank H. Oberle
Minister of State
Science and Technology
Government of Canada

The Hon. Hugh O'Neil
Minister of Industry, Trade and Technology
Government of Ontario

The Hon. Roland J. Thornhill
Minister of Development
Government of Nova Scotia

The Hon. Fernand G. Dubé
Minister of Commerce and Technology
Government of New Brunswick

The Hon. Vic Schroeder
Minister of Industry, Trade and Technology
Government of Manitoba

The Hon. Patrick McGeer
Minister of International Trade, Science and Investments
Government of British Columbia

The Hon. Hal Barrett
Minister of Development and Tourism
Government of Newfoundland

The Hon. Tony Penikett
House Leader
Government of Yukon

David Berger, M.P.
Standing Committee on Research, Science and Technology
House of Commons

David Daubney, M.P.
Standing Committee on Research, Science and Technology
House of Commons

Joan Dougherty, députée
Secrétaire parlementaire de Monsieur Claude Ryan
Ministère de l'Enseignement supérieur et de la science
Gouvernement du Québec

Suzanne Duplessis, députée
Comité permanent de la recherche de science et de
la technologie
Chambre des communes

Claude Lanthier, député
Secrétaire parlementaire de l'honorable Frank Oberle
Chambre des communes

Howard McCurdy, M.P.
Standing Committee on Research, Science and Technology
House of Commons

Guy Ricard, député
Secrétaire parlementaire
Comité permanent de la recherche de science et de
la technologie
Chambre des communes

Guy Rivard, député
Secrétaire parlementaire de Monsieur Pierre MacDonald
Ministère du Commerce extérieur et du Développement technologique
Gouvernement du Québec

Bill Tupper, M.P.
Chairman of Standing Committee on Research, Science and Technology
House of Commons

Mark Abbott
Science and Technology Committee
Canadian Manufacturers Association/Association des manufacturiers canadiens
Vice-President
Polysar Limited

W. Peter Adams
Executive Director
Association of Canadian Universities for Northern Studies/
Association universitaire canadienne d'études nordiques
Professor
Department of Geography
Trent University

Robert Alden
Vice-Chairman
Institute of Electrical and Electronics Engineers
Professor
Department of Electrical Engineering
MacMaster University

Trevor M. Apperley
Director
Corporate and Investor Relations
Develcon Electronics Ltd.

Dan Archer
Technology Division
Ministry of Industry, Trade and Technology
Government of Manitoba

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Government of New Brunswick

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Alberta Laser Institute
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Social Science Federation of Canada/Fédération canadienne des sciences sociales
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Corporate-Higher Education Forum
Director of University Liaison
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University of Victoria

Susan Attenborough
National Representative
Canadian Labour Congress

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MPB Technologies Inc.
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Aurèle Beaulnes
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Jim Bennett
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Canadian Federation of Independant Business/Fédération canadienne de l'entreprise indépendant

Guy Bertrand
President
Centre de recherche industrielle du Québec

Alec Bishop
Vice-President
Aerospace Industries Association/Association des industries aerospaciales du Canada

Cam Blachford
Associate Vice-President
Research and Graduate Studies
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École Polytechnique

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Telecommunications and Informatics
Department of Communications

Pierre Bois
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Conseil de recherches médicales

Val Bourgeois
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International Association of Machinists and Aerospace Workers

John Bracken
Chief of Staff
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Director of Operations
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Natural Sciences and Engineering Research Council

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SPAR Aerospace Ltd.

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Vice President
New Brunswick Federation of Labour

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Association for the Advancement of Science in Canada/
Association pour l'avancement des sciences au Canada
Director
National Museum of Science and Technology

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Associate Dean, College of Graduate Studies and Research
University of Saskatchewan

Kathy McMullen
Economist
Economic Council of Canada

Claire McQuillan
Policy Analyst
Privy Council Office

C. George Miller
Managing Director
Mining Association of Canada/Association minière du Canada

George Miller
President and Director of Research
Nova-Husky Research

Larry P. Milligan
Dean of Research
University of Guelph

Sid Monaghan
Member
Aerospace Industries Association/Association des industries aerospaciales du Canada
Chief R&D Support
Pratt and Whitney Canada

Doug Moodie
Director
Technical Services
Department of Development and Tourism
Government of Newfoundland

Fraser Mustard
President
Canadian Institute for Advanced Research

Arnold Naimark
President
University of Manitoba
Association of Universities and Colleges of Canada/
Association des universités et collèges du Canada

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University of Saskatchewan
and Member, Science Council of Canada

Robert D. Neill
Chief Executive Officer and Chairman of the Board
Neill and Gunter Ltd.

Jack Newhouse
Business Equipment Manufacturers Association of Canada
Manager, Development Operations
IBM Canada)

Lucie Nicholson
General Vice-President
Canadian Union of Public Employees

Tom Nickerson
President
Nova Scotia Research Foundation Corp.
Government of Nova Scotia

David M. Nowlan
Vice-President, Research
University of Toronto

Sean O'Flynn
Secretary Treasurer
Ontario Federation of Labour

Art Olson
Assistant Deputy Minister
Research and Resource Development
Alberta Agriculture

Théo Olthof
Vice-President
Professional Institute of the Public Service/Institut professionnel de la fonction publique
Research Scientist, Department of Agriculture

Bill Oppen
Director
Policy and Intergovernmental Relations
Executive Council Office
Government of Yukon

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The Fraser Institute
Professor
School of Business
Queen's University

Gilles Paquet
Président
Association canadienne-française pour l'avancement des sciences

Jean-Maurice Paradis
Conseiller en relations intergouvernementales
Secrétariat aux Affaires intergouvernementales canadiennes

Kevin Park
United Food and Commercial Workers

Hal Parker
Business Development Officer
Department of Industry
Government of Prince Edward Island

Jean-Claude Parrot
Président
Syndicat des Postiers du Canada

Dominique de Pasquale
Présidente
Association des communicateurs scientifiques du Québec

Arthur Pearson
President
Rampart Group

G. Ross Peters
Dean
Faculty of Engineering and Applied Sciences
Memorial University of Newfoundland

Anthony Pollard
Senior Government Liaison and Public Relations Officer
Canadian Council of Professional Engineers/Conseil canadien des ingénieurs

Christiane Quérido
Présidente, directrice générale
Fonds pour la formation de chercheurs et l'aide à la recherche (FCAR)

W. Howard Rapson
President
Chemical Institute of Canada/Institut de chimie du Canada
Professor
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BUILDING ON

OUR

STRENGTHS

A Background Paper for the National Forum
on the National Science and Technology Policy
Winnipeg, June 1986

Prepared by the Ministry of State
for Science and Technology, Ottawa

May 26, 1986

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EXECUTIVE SUMMARY

This background paper for the National Forum provides a general overview of the major characteristics of the Canadian scientific and technological effort. It does so within the framework set last year by federal and provincial Ministers responsible for science and technology to establish a National Science and Technology Policy.

The paper assesses the major international and domestic forces that will help define Canada's thrust in science and technology. Among the international trends are the tendencies towards the internationalization of R&D and the focus by nations on concerted strategies for developing new technologies. On the domestic front, Canada is attempting to meet this challenge, but is faced with certain structural and institutional deficiencies. Among these are the weak private sector R&D infrastructure, and the fragmented science and technology base.

These matters suggest there is an urgent need for Canada to develop a cohesive approach to the new challenges and to define the objectives of a National Science and Technology Policy.

The paper then presents four themes that provide the agenda for discussing the parameters of a National Science and Technology Policy.

The development and acquisition of new knowledge is a theme that revolves largely around the role of universities in basic research and in the training of highly-qualified personnel. There is considerable evidence to suggest that the strength of our university system is weakening due to underfunding, growing obsolescence of the research infrastructure, aging of the research faculty, and threats of a brain drain of key, young scientists and engineers.

The federal laboratories, technology centres and provincial research organizations represent another critically important but fragmented source for acquiring and developing new knowledge. Canada has strengths in certain key technologies of strategic importance that will need further development and strengthened long-range national plans.

Putting this knowledge to work and realizing opportunities will require a special effort by the private sector: a sector that has certain structural features that make the task a daunting one. Governments have a critical role to play in providing an appropriate climate for investment in science and technology. This includes using procurement mechanisms to greater effect, encouraging foreign investment, promoting small business development, enhancing trade strategies, and optimizing the use of the Economic and Regional Development Agreements.

All of this requires a national ability to adapt to change effectively. Public awareness programs need to be enhanced, our young people must be better prepared through a strengthened science education system, and our work force must become better adapted to the effects of technological change. As the paper also points out, management has to increase its ability to understand and introduce new technology within the productive sector.

For each of the above three themes, the paper highlights some of Canada's strengths and opportunities in the area of science and technology. These include developments in the telecommunications and aerospace sectors, as well as the recent initiatives to bolster Canada's space program. New initiatives in science and technology are on the rise, particularly with the increased participation of provincial governments in formulating science and technology policy strategies and/or implementing new measures to strengthen industrial innovation and entrepreneurship.

Putting a national science and technology policy to work implies that:

- clear focal points must be created for a national technological effort and must involve a cooperative venture of all productive sectors of the economy;

- a solid basis for accumulating and transmitting knowledge and know-how must be put in place; and

- there must be an appropriate climate for innovation and entrepreneurship.

PREFACE

This document was prepared by the Ministry of State for Science and Technology to serve as background material for the National Forum to be held in Winnipeg, June 9-10, 1986, to discuss the development of a National Science and Technology Policy.

It is designed to give participants a quick overview of some of the key issues affecting science and technology development in Canada so that an informed debate can take place. As such, the paper does not provide any policy options or recommendations. It is recognized that some of the statistics used in the text can be queried; nevertheless the figures that are presented are those that have been generally accepted in representing the state of the nation's science and technology activities. Similarly, the reader should also be aware that the science and technology policy debate in Canada has had a long and somewhat checkered history. The Special Committee of the Senate on Science Policy of the late 60's and early 70's, as well as the work of the Science Council of Canada and the OECD helped set the early tone for this debate. Since then, many organizations, including the Economic Council of Canada, the Fraser Institute, the now defunct Canadian Institute for Economic Policy, and most recently, the Macdonald Royal Commission on the Economic Union and Development Prospects for Canada, have been quite active in stimulating national discussion on this vital issue from several - and sometimes quite different - perspectives. In addition, various provincial organizations and commissions have also made an important contribution.

The reader should also recognize that the use of the phrase science and technology throughout the text is merely a shorthand convenience; there are instances where institutional norms that apply to science (e.g. peer review) do not apply to technology, and vice versa.

Furthermore, the scope of the discussion regarding science and technology policy is deliberately broad, and quite often overlaps with industrial policy, foreign policy and the like.

The paper is premised on the commitment in February, 1985 by federal, provincial and territorial ministers responsible for science and technology to formulate a National Science and Technology Policy. The February ministerial meeting resulted in the identification of three strategic priorities. Governments agreed to:

1. Strengthen private sector investment in innovation;

2. Encourage the transfer and application of technology;

3. Support important basic research to develop longer-term scientific expertise and industrial leadership for the country.

The latter priority emerged as a major discussion point in a subsequent meeting of ministers at Meech Lake in September 1985.

For the purposes of building on the ministerial initiatives in Calgary (February 1985) and Meech Lake (September 1985), it was felt important to have a national discussion on a focussed set of issues that relate directly to the three strategic priorities agreed to by ministers. The result is this document which discusses the following key themes:

1. How to better develop and acquire new knowledge.

2. How to more effectively put this knowledge to work and realize opportunities.

3. How to ensure the involvement of all Canadians and fostering an ability for adapting to change.

4. How co-operatively to put a national policy to work.

There is a degree of overlap among these four themes, but they each draw together a number of important issues and are intended to assist the debate regarding a National Science and Technology Policy.

Subsequent to the Forum, the Minister, together with his ministerial colleagues from provincial governments and territories, will consider the input from this and other consultative mechanisms with a view to the preparation of a National Science and Technology Policy statement. The Forum offers all sectors an opportunity to identify and comment on the objectives, goals and optimum courses of action to be pursued in shaping Canada's science and technology effort.

MOSST would like to acknowledge and greatly appreciates the contribution of the organizations and individuals who have provided inputs and advice in the development of this document.

INTRODUCTION

Canada is now facing major challenges to its economic and social well-being brought about by significant technological change. The need to bring together a concerted focus for managing these scientific and technological developments is made all the more pressing because of several critical phenomena; both international and domestic:

International

1. The trend in most industrialized countries is to develop concerted plans or strategies for science and technology at the national level. Much of this has focussed on innovation policies directed to the promotion of strategic technologies such as microelectronics, advanced industrial materials and biotechnology.

2. The internationalization of industrial R&D is occurring at a greater pace. This involves cooperative R&D projects not only between firms responding to global pressures by focussing on precompetitive projects, but also bilateral and multilateral ventures between nations in pooling resources together on major projects. The Eureka and Esprit initiatives among several European nations are such examples.

3. We see an increased concentration by newly-industrialized countries (NICs) on technology. NICs are not only threatening the market share of our traditional resource-based industries, but the NIC share of imports of high technology products has significantly increased. Among OECD countries as a whole, the NIC share of imports of high technology products has increased from less than 1% in 1964 to 12.1% in 1984. These NICs (e.g. Brazil, Mexico, Korea, Hong Kong, Singapore) are clearly shifting their emphasis from low to high technology manufactured exports, and this will have significant bearing on Canada's ability to meet the global, competitive challenge. At the same time, Canada's

high tech trade exports to NICs have to deal with various forms of non-tariff barriers.

4. A global phenomenon of increasing importance and concern is the growing division of the world, not just into trading blocs, but into technology blocs which actively restrict technology flows to countries they see as competitors. The problem of access to technology is emerging as an issue in our relations particularly with the U.S., but also with Europe, and to some extent, Japan. As a medium economy, not part of a major bloc, Canada will have to deal with the trend towards technology protectionism.

Domestic

These global trends place Canada at a major disadvantage on the domestic front. (See Appendix A for table of selected statistics of Canada's scientific and technical activity.) Specifically,

1. Canada as yet has no concerted, focussed strategy to mobilize its scientific and technological resources. What coordination exists between the federal and provincial governments in structuring programs and policies designed to encourage innovation must be strengthened.

2. The industrial R&D infrastructure in Canada is weak and lacks depth. Canada has few major R&D industrial performers. The economy's structural characteristics with foreign firms operating large subsidiaries has had, historically, a significant influence on the low level of R&D investment by industry. Canada has major weaknesses in the high technology sector where the overall trade deficit in 1984 was $12 billion.

3. Our resources sector, (the major contributor to our comparative advantage) is suffering. In certain areas, depletion of resources - overfishing, soil erosion, excessive felling - has undermined the strength of the resource industries, and there is no strong processing sector to fall back on. Canada's capability to compete on world markets is in jeopardy. Competition from industrialized and newly-industrialized economies is encroaching

on Canada's traditional share of world trade in natural resources, and is weakening its hold on long-standing key markets. In R&D performance, Canada's resource industries generally do not compare well with the international competition. A little understood phenomenon, but one that should be assessed, is the extent to which certain resource-related activities and foreign-aid programs have helped create some of the competition now being faced by Canadian industry in certain foreign markets.

4. Canada's overall S&T infrastructure is fragmented and does not have well-developed networks of communications. Collaboration between and among technology centres, industrial research associations, government research laboratories, university research institutes and provincial research organizations could be strengthened.

The Necessity for Action

Given these domestic and international features affecting the development of science and technology, several issues should be noted. First, it would be misleading to suggest that Canada is at a complete standstill in meeting the challenges of technological change. Both the federal and provincial governments have sought to introduce measures to enhance the country's scientific and technological effort. Many provinces are currently reviewing science and technology strategies designed to promote industrial innovation and economic renewal. In some instances, this has involved the strengthening of the existing technology infrastructure, such as a provincial research organization; in others, it has meant the creation of new innovation centres or incubator facilities. Some provinces have also focussed on promoting technology transfer, particularly in the area of university-industry alliances, while others have been engaged in a dialogue to better manage change brought about by technology.

The federal government has been equally active. Measures to streamline the tax incentives and grant support schemes for industrial R&D have been introduced. The May 1985 federal budget introduced an improved definition of R&D, a refundable tax credit for Canadian R&D firms, and set out several new initiatives

to increase the availability of capital for entrepreneurial and innovative ventures. Reviews are underway of the technology centres financed by the federal government, and of our foreign technology acquisition programs, with a view to strengthening the national system of technology diffusion. The government has also announced a long-term Canadian space program, which includes measures to encourage our participation in the Space Station. New, five-year financing for the granting councils has also been provided.

Despite this activity, however, the two levels of government need to improve their co-ordination in science and technology.

Second, the fact that most industrialized nations have recognized that a concerted approach to investment in innovation - in partnership with the public, private and academic sectors - is necessary for economic survival, let alone industrial competitiveness, is all the more reason for Canada to map out its strategy on the scientific and technological front.

Finally, the difference between a nation that is scientifically and technologically avant garde and one that is laggard lies not solely in the measures and resources in place to promote science and technology, but is also defined through cultural attitudes to innovation. Science and technology need to be moved from the periphery to the centre of government thinking and government policy. It is not enough that the value of R&D, for example, be demonstrated through its significant social and private rates of return. This has clearly been demonstrated. It is important to have society recognize the contributions of its scientists, engineers and entrepreneurs through various reward systems such as prizes and awards of distinction and merit. The attitude of senior decision-makers, both in the private and public sectors with respect to the important role of science and technology in society has to be nurtured. This can be done through various means. These range from strengthening public awareness and science education throughout our school system to promoting creative management techniques in the adoption of technology.

For these very important reasons, it is critical that a National Science and Technology Policy urgently be formulated. Such a National Policy will provide for the following objectives:

- To establish Canada's position in the international milieu of economic competitiveness and productivity.

- To provide leadership and a firm sense of direction in science and technology.

- To identify gaps and opportunities in Canada's science and technology infrastructure.

- To build upon provincial and territorial economic priorities and opportunities.

- To provide a framework for the integration of science and technology into the development of policies and strategies in other, related domains.

In order to fully meet these objectives, an agenda to guide discussion on a National Science and Technology Policy must be developed. The agenda is part of a process that must include an action plan to implement the key decisions arising from critical questions. The central questions that must be asked and assessed are:

- How can Canada better develop and acquire new knowledge?

- How can Canadians put this knowledge to work and realize opportunities?

- How can Canadians better cope with and adapt to change brought about by science and technology?

- How can a National Science and Technology Policy be best put to work?

We shall explore each of these issues in the following section.

THE AGENDA FOR A NATIONAL SCIENCE AND TECHNOLOGY POLICY

1. Developing and Acquiring New Knowledge

The acquisition and development of new knowledge is primarily a function of the basic research capacities in our universities and federal government laboratories. The heterogeneity of our university system makes it difficult to generalize; nevertheless, certain features should be noted. While there are over 70 degree-granting institutions in Canada, not all of them have a significant research function. In fact, of the top 30 universities that conduct research, fourteen Canadian universities are responsible for 75% of sponsored research in post-secondary institutions. These are the so-called "research intensive" universities which receive funds from granting councils, provincial governments and the private sector.

Highly-Qualified Personnel and Basic Research

The stock of R&D personnel in our higher education sector has remained remarkably stable from a complement of 13,150 person-years in 1976 to 13,630 in 1983. There is some question as to whether this cadre of researchers is sufficient to meet the increasing levels of demand for the training and re-training of highly-qualified personnel.

If Canada is to cope adequately with the advent of new and strategic technologies, it must have adequate numbers of trained, skilled personnel. NSERC, for instance, has calculated that with reasonable economic growth until 1990, Canada will need 1600 new researchers at the PhD level to meet R&D levels of 1.5% of GNP. There is barely half that total in our academic institutions right now. Canada must also be concerned with the so-called "seed corn" issue - more specifically, faculty must be available in sufficient numbers to teach the science and engineering students bound for industrial jobs in certain key scientific fields.

The question of providing adequate and stable support for our pool of basic researchers poses several challenges to all.

- There is a longer-term need to improve the science teaching at all levels of our school system, particularly, as the Science Council of Canada has pointed out, in the primary and secondary schools, and to encourage more students, especially women, to study relevant subjects.

- We must enhance the capabilities for R&D in our post-secondary institutions in order to maintain Canada's competitive position among developed nations. The Council of Ministers of Education has recognized this issue and is calling upon the provincial and territorial governments to meet the challenge.

- A related issue is the perceived threat (though still not adequately documented) of a "brain drain" from this country to greener pastures elsewhere. Assuming that the greater part of this mobility is to the U.S., recent figures from the National Science Foundation would appear to indicate that, since 1982, the number of immigrant scientists and engineers that are Canadian by birth or listed Canada as their last permanent residence is actually on the decline. Sheer numbers, however, do not present a good measure of the quality of the individuals that have left Canada, and this must be carefully considered.

Concern has been expressed in the past over the instability of funding for university research which has led to declines in the acquisition and maintenance of scientific equipment; decline of foreign student enrolment due to higher tuition fees; and an aging faculty whose median age is now 44, whereas in 1970 it was 37. The combination of these factors has made it difficult to attract and keep young, world-class researchers in Canada.

Recent analysis by NSERC suggests that the erosion of university financing from 1970 to 1983-84, as indicated by universities' capacity to support teaching and R&D has been significant. According to this analysis, the largest contributing factor to the erosion of universities' ability to perform is the decline in funds available for capital expenditures.

It is not just the higher education sector that has complained about the situation. Numerous organizations, including the Science Council of Canada, the Canadian Chamber of Commerce, the Canadian Manufacturers' Association and high-tech firms such as Northern Telecom and SED Systems, have been vocal about the crisis affecting many of our Canadian universities. As David G. Vice, President of Northern Telecom Ltd., has recently put it:

> "Upgrading our universities' research facilities is a pivotal action. These institutions occupy a critical position with the research triad composed of private laboratories, government facilities and post-secondary institutions. University laboratories can and should be leaders in the area of basic research. Still more significantly, post-secondary institutions remain our prime source of the trained personnel needed by a dynamic society."

As Mr. Vice goes on to note, Canada must be able to cope with a turbulent and increasingly competitive world that competes on brainpower and new knowledge. The importance of basic research, for example, is now taking on new critical dimensions in the U.S., the U.K. and Japan.

In Canada, this has not gone unnoticed. In the federal government's most recent budget, it was announced that the budgets of the three granting councils would be increased by an anticipated $1 billion over the next five years, contigent, in part, on investment from the private sector. This initiative is a significant one in several respects. It provides the granting councils with a stable base of funding for the next five years, and therefore will allow the research community to obtain reliable long-term funding. Second, the commitment of such a substantial amount of money given the current fiscal situation signals the federal government's recognition of the importance of maintaining Canada's vital research infrastructure. Third, the funding formula will allow for greater university - industry alliances, and thus promote the transfer of knowledge.

It should also be noted that some provincial governments are also active in strengthening their research systems. Québec, for example, is committing approximately $75 million over the next five years to develop forty research teams of critical size in the province's universities. Quebec's two other major

sources of funds for university research - the granting councils for scientific and medical research - totalled $51.5M in 1985-86. Alberta's $300 million Heritage Foundation for Medical Research is another unique example of significant investment in developing world-class medical research. The Foundation has succeeded in attracting over 85 Heritage Medical Scientists to the Universities of Calgary and Alberta and these scientists have over 300 graduate and post-doctoral students working under them. The Foundation also hopes to develop an Alberta-based medical industry.

Corporate-Higher Education Alliances

Accessing the new knowledge demands not only the use of the resources of our Canadian universities, but also the capabilities of partnerships between different sectors. Corporate-higher education linkages are one of the best expressions of this new co-operative form. The recent announcement by the federal government to match private sector contributions to the granting councils for university research is the latest in a series of initiatives to promote greater university-industry linkages.

The Corporate-Higher Education Forum, an organization whose members include the Chief Executive Officers of Canada's major corporations and the Presidents of most research-intensive universities, estimates that about $52M was spent on corporate support of university R&D in Canada in 1984. This is 2% of total corporate spending on R&D, and represents just under 1% of total current university expenditures.

Despite this small sum, the number of institutional co-operative arrangements that exist is impressive. The innovative models of the Centre for Cold Ocean Resources Engineering in St. John's, the Veterinary Infectious Disease Organization in Saskatoon, and the Centre for Frontier Engineering Research in Edmonton are excellent experiments using private foundation funds and government and industry support to work with academic researchers on applied research projects. Another specific example is that of the Institut national de la recherche scientifique - Télécommunications which works jointly with the Bell Northern Research labs in Montréal, and offers degree programs aimed at university graduates. Industrial research chairs at universities, co-op programs, industrial research institutes, innovation centres,

advanced technology centres, offices of technology transfer and the like, provide other examples. The efforts in this area, however, pose serious questions about the proper role of universities and that of the private sector. Questions surrounding conflict of interest, intellectual property, research evaluation, and strategic roles, among others, are being seriously debated. Several Canadian universities, for example, have been quite active in developing strategies and guidelines for dealing with the private sector.

Federal Laboratories

More will have to be done in exploiting the development and acquisition of new knowledge from our government research laboratories and provincial research organizations. There are over 200 federal government laboratories spread all across the country, with a total annual budget of approximately $1.6 billion. These laboratories employ about 8,100 scientists assisted by over 17,000 support staff. The leadership role in technology development demonstrated by some of these organizations, such as the National Research Council, the Department of Communications and the CANMET laboratories of the Department of Energy, Mines and Resources, has been significant.

The Science Council of Canada has pointed out that federal laboratories were established at different times to serve different purposes, and over time, their activities have, in some instances, become diffuse, vague, and may appear to be inconsistent with contemporary needs. The Wright Task Force Report has suggested that the laboratories be reviewed and required to demonstrate their relevance and usefulness. The Nielsen Task Force on Program Review has undertaken some of this work, and has recommended areas where the enhanced delivery of new knowledge can be effected. The federal laboratories are responding to this challenge, and are currently assessing ways in which they can become more effective and more responsive to client needs.

The National Research Council, for example, has recently announced in its latest five-year plan that encouraging and assisting Canadian industries to implement technological solutions will be its major role. In realigning its research program, the Department of Communications is putting major emphasis

on areas where government requirements - for internal efficiency or better service to the public - provide opportunities to work in partnership with universities and the private sector, with the aim of developing new technologies in harmony with novel approaches to organization and human resource development.

Technology Centres

The network of technology centres that service the needs of industry across Canada are also under scrutiny. The biggest problem facing the more recently-created technology centres appears to be one of sub-critical size and fragmentation. The private sector has been especially critical of this latter aspect, arguing that governments should be concentrating their resources on excellence, rather than continuing to fund centres of sub-critical size and on inadequate economic and technical grounds. The federal government, through MOSST, is currently exploring methods by which these technology centres can be more effectively rationalized, and ways in which they can better achieve their objectives of technology diffusion.

Several provincial governments have instituted a number of technology-specific centres whose purpuse is to assist in the diffusion of technical information to clients. Ontario and Québec have especially been active in this area. In addition, the eight provincial research organizations (PROs), with budgets totalling $125 million and employing over 1,800 people, must be more effectively drawn upon for their expertise in assisting small and medium-sized businesses. The PROs are a significant resource for regional development as well, and are an excellent example of federal-provincial and inter-provincial collaboration in delivering generic technical assistance to numerous clients across Canada. Their ability to draw on foreign expertise as well should not be overlooked. For instance, the eight PROs have just completed a major mission to West Germany in which they met with over thirty research institutions. As a result, several of the PROs have concluded informal arrangements for exchange of technical information and projects to assist Canadian firms.

Canada's Position in World Science

Canada contributes about 4% of the world's scientific literature and develops about 2% of the world's technology. Canada relies extensively therefore

on its international network for knowledge. In the scientific field, there is some concern that Canada's strength in certain scientific fields is declining. Our share of scientific publications worldwide (albeit a partial and still controversial indicator of Canada's scientific health) has declined from 1973 to 1982. Some to reverse themselves. For example, of the top 100 most-cited 1982 articles in the field of chemistry from 1982 to 1984, Canadian research institutions produced 10 of these papers; six alone from the Guelph-Waterloo Centre for Graduate Work in Chemistry. This is encouraging, but other research areas are in jeopardy. For example, the Conseil de la science et de la technologie du Québec is currently assessing the health of plant biology in that province as a result of concerns that the field's decline might seriously affect the prospects for biotechnological developments.

Foreign Technology

A significant portion of the world's technology base is produced abroad. In order for Canada to prosper or even survive in this technological era, the paramount concern of our international technology relations must be to encourage and facilitate the acquisition of foreign technology by the productive parts of the Canadian economy, notably the private sector. A variety of mechanisms can be used to this end, including technology missions, exchange agreements, technology officers in Canadian posts abroad, and programs such as the new Technology Inflow Program (TIP), but these mechanisms should be strengthened. Above all, Canadian firms and technology organizations need good information on and access to new technology. In the area of artificial intelligence, for example, the Canadian Society for Fifth Generation Research has been successful in negotiating a memorandum of understanding with Japan that will allow for the exchange of research personnel and information.

Patents are another source for accessing foreign technology. Patent information, however, is vastly underutilized by Canadian firms and research institutions, thereby diminishing the efficiency of foreign technology exploitation. A study by the U.S. Patent Office showed that as much as 70 percent of the material covered by U.S. patents had not been described elsewhere in the five years after the patents were granted. For a country like Canada, where the vast majority (94%) of its national patents are granted to

foreign applicants, the efficient diffusion of the technological information contained in Canadian patents would go a significant way to improving the productivity and competitiveness of Canadian firms.

In recent years, the Canadian Patent Office has undertaken to promote the diffusion of domestic and foreign technology by providing a technology search service to small manufacturing firms through a nation-wide network of intermediaries, including provincial research organizations, innovation centres, and various federal and provincial agencies.

Closely-related and equally important to the matter of foreign technology is the need to address the growing problem of restricted access to foreign technology or technology protectionism. This issue is a global phenomenon, but one which will strike home particularly in the current context of the bilateral trade negotiations with the United States. The Science Council of Canada has just released a statement that highlights the need for putting technology up-front in these trade negotiations. The Council suggests several ways by which this can be done and it recommends that the negotiations give adequate consideration to the impact of liberalized trade on Canadian R&D, and to key measures to promote technological capability.

The matter of freer trade is obviously quite a sensitive one with governments. Already, for example, Canadian procurement policies in certain fields have been challenged in the course of the American government's preparatory discussions for the next round of multilateral GATT negotiations. Thus, a great deal of complexity and importance surrounds the issue of placing technology up-front in trade negotiations. Several industry associations, including the Canadian Advanced Technology Association, have been quite active in highlighting their positions on this issue.

From a wider perspective, some fundamental questions need to be raised in considering the absorption and accession of foreign technology. These relate to the proper balance between adequate support for domestic R&D capability and support for our ability to absorb foreign technology. This is a very complex issue and requires a sound assessment of a nation's overall science and technology infrastructure. One OECD commentator, for example, in reviewing the success of the technology policies of several European countries and the U.S., has suggested that about five per cent of a

nation's technical resources might be spent on developing new technologies, with the remainder spent on diffusing or incorporating these technologies into standard business practices.

Strategic Technologies

Canada will also have to be selective in its development and application of emerging sciences and technology of strategic importance to the country. While Canada has some research capability in the "core" technologies now developing, such as microelectronics, biotechnology and advanced industrial materials, many are concerned that the base is too small, and the need for a national effort in the area is required, perhaps with the increased development of national facilities.

In some specific technologies, Canada is doing relatively well. According to a national consultation on emerging technologies undertaken by the Science Council of Canada, Canada is among the world leaders in telecommunications, enhanced oil recovery techniques, synthetic fuels, remote sensing, computer software, and hydrogen technologies. Significant capabilities also exist in the areas of advanced alloys, composite materials, conducting materials, biomass technologies, mineral leaching, coal technologies, ice engineering, and construction technologies. Nevertheless, in the major enabling technologies, Canada's effort at development work is insufficient and there is a balkanization of the national effort.

These and other areas must be more effectively explored if Canada is to develop and acquire new knowledge critical to the economic survival of this country. We have to understand not simply the structural and institutional features of science and technology but cultural parameters, such as the effects of biculturalism in research, the special context of the North, and the role of public awareness, as well. The Québec Conseil de la science et de la technologie, in its current 1985 annual review, has been especially eloquent on the first of these questions, and has gone to considerable lengths to discuss the distinctions between the anglophone and francophone university research systems in that province. New Brunswick and Ontario also have an interest in this issue. In New Brunswick, for example, the development and delivery of technical assistance programs in both official languages through the university system there poses significant challenges to the institutions involved. As one expert commentator has remarked, the distinctive national style of Canada's science and technology institutions makes our situation sui generis.

Summary of Issues

The issues raised in this section highlight the various elements necessary for acquiring and developing new knowledge. These include science education in our schools, the stock of highly-qualified personnel and the universities' role in basic research; corporate-higher education alliances; the federal laboratory complex; technology centres; Canada's status in world science; the acquisition of foreign technology and the development of strategic technologies domestically. Several key questions are raised in light of the current context. Among these are:

- **What measures need to be taken to strengthen the scientific and technological research base in Canada's higher education sector?**

- **How can the private sector be encouraged to have a greater involvement in publicly-funded research institutions?**

- **How should we be strengthening the mechanisms available to facilitate the acquisition of foreign technology by the productive parts of the Canadian economy?**

- **What can be done to ensure that corporate - higher education partnerships are strengthened?**

2. Putting Knowledge to Work and Realizing Opportunities

Technological innovation has played an increasingly important role in fueling economic growth in Canada, as well as its major competitors. Putting our knowledge to work and realizing opportunities is heavily dependent on the dynamism and entrepreneurial activity created by a nation's economic engine - the private sector. The climate for innovation in any nation is affected by several variables. These include the structural features of the economy; the cultural attitudes to science and technology; the science and technology base available; the general incentives to innovation; and the capability of the individual firm. Unfortunately, Canada possesses major deficiencies in each of these factors. Table I presents our scorecard with respect to a selection of such measures based on OECD comparisons.

TABLE I

Measure	Canadian Rank Within OECD
GERD/GDP	10
R&D/Sales	
- Chemicals	8
- Electric Machinery	6
- Aerospace	5
- Electronic Components	4
- Drugs and Medicine	7
- Instruments	9
Number of R&D Scientists and Engineers	7
Creativity	8
Productivity	7
Market Share of OECD Exports of High Intensity Products	8
Business Expenditures for R&D/GDP	10

Source: OECD (based on latest data)

Structural Characteristics of the Economy

Structural features of the Canadian economy are often blamed for the poor investments by firms in R&D and science and technology. Canada ranked 10th in GERD performed and funded by business enterprises as a percentage of GDP in 1982 (See Table II). Canada's economy is characterized by a significant degree of foreign ownership and control that has led to a branch-plant economy heavily reliant on R&D performed elsewhere. The country's manufacturing base is found in the Central Canada heartland, and industrial development policies, as a consequence, have had to contend with diversification and regional equity. This, combined with a corporate culture that is largely risk averse, has made the issue of underinvestment in R&D and innovation a fundamental matter that must be solved if Canada is to make its mark on the world economy.

TABLE II

	GERD/ GDP (1984)	GERD/ GDP (1982)	GERD Funded by Business Enterprises as % of GDP (1982)	GERD Performed in B.E. Sector as % of GDP (1982)
Canada	1.35	1.36	0.52	0.65
U.S.	2.70	2.66	1.33	1.94
U.K.	2.27[1]	2.42[2]	1.00[2]	1.50[2]
Germany	2.58[1]	2.58	1.47	1.80
France	2.22	2.10	1.47	1.21
Sweden	2.47[1]	2.22[2]	1.27[2]	1.48[2]
Switzerland	2.28[1]	2.29[2]	1.56[2]	1.70[2]
Japan	2.61[1]	2.47	1.57	1.53
Austria	1.25	1.22	0.59[2]	0.65[2]
Netherlands	2.00	1.98	0.89	1.02
Norway	1.41[1]	1.29[2]	0.52[2]	0.67[2]

1 1983 figures
2 1981 figures

Source: OECD

Management Attitudes to Innovation

Within the corporate world, there is evidence that senior level management perspectives on the value of research and innovation leave much to be desired. A recent study by Arthur D. Little, Inc. on the innovation management practices among firms suggests that North American firms lag behind both Japanese and European companies in regard to corporate expectations for the contribution of innovation. One of the reasons cited for this is that North American firms tend to believe that innovation is the province of scientists and specialists - not operating management. Many Canadian firms, in particular, often display this characteristic. A January 1986 report on technology transfer, released by the Ontario Ministry of Industry, Trade and Technology, suggests that if technological upgrading in Ontario's manufacturing industries is not meeting expectations, it is attributable, in part, to management's resistance to change. This attitude is reflected

in the general lack of interest by firms, especially small businesses, in coping with technological change by training their employees for specific job-related skills. A 1984 survey by the Ontario Manpower Commission noted this deficiency. According to the survey, only 2.7 percent of all employees received formal qualifying or upgrading training that lasted two weeks or more. Some 80 percent of all establishments did not sponsor qualifying or upgrading programs.

Measures of Private Sector Performance in Science and Technology

Other indicators tell a disturbing story. Canada's expenditures on industrial R&D ranked seventh in 1981 among OECD nations. We were eighth in terms of market share of OECD exports of R&D intensive products, and that market share is slipping. Our trade deficit in high-technology (an area that contributes to significant value-added) is the worst among the Economic Summmit countries. In 1984, according to a MOSST analysis, this deficit amounted to $12 billion, and it continues to grow. According to the European Management Forum's 1985 Report on International Competitiveness, Canada ranked 15th out of 22 countries in "innovative forward orientation" - a measure of a nation's acceptance of technology. The same rating is given to Canada for "outward orientation" - a measure of a nation's international market presence.

Most of our resource-based industries - the economic backbone of our country - have seen their market shares slip due to increasingly heavy competition from newly-industrialized countries. Foreign government subsidies, falling demand, and substitution are other factors that have also had an impact. Canada has been slow to adopt new technologies that will enhance our trade in agriculture, wood, fish and minerals, though this latter sector has developed some interesting new initiatives in the area of remote sensing, ceramics and advanced materials.

A creativity index compiled by the European Management Forum based on the average annual number of patents granted to residents per 100,000 inhabitants from 1980 to 1982 shows that Canada ranked 8th among industrialized nations. In the area of biotechnology, for example, our patent activity is anemic. Canada ranked 11th after such countries as Italy, Denmark, Sweden and the Netherlands in the number of U.S. patents issued in selected patent classes affecting biotech-

nology from 1973 to 1983. Canada's share of patented product inventions is low in other high technology product areas such as pharmaceuticals, medicine and office, store, and business machines.

Availability of qualified personnel is, in some instances, a problem. In the Conference Board of Canada's second annual survey on R&D in the corporate sector, over one-third of survey respondents noted that they currently experience shortages of qualified R&D personnel. Shortages are more acute for those companies within the high-technology group, in which 57% currently experience a lack of skilled personnel. These shortages are expected to worsen over the next five years.

The venture capital picture in Canada has not been very promising, though it is hoped that the recent capital gains tax exemption introduced by the federal government will encourage Canadians to invest in new and growing innovative enterprises. The total of all venture capital investment in Canada in 1983 was estimated at slightly more than $100 million. Less than $10 million of this amount went into start-ups. Nearly 40% of all Canadian venture capital investments are currently in the United States. Pre-venture capital and seed financing in this country is virtually non-existent.

Despite increasing its share both as a funder and as a performer over the past decade, private sector investment in science and technology needs considerable strengthening. It needs to be encouraged because study after study has proven that significant spillover benefits accrue to firms, and to the nation as a whole, by investing in R&D. Estimates for the social rates of return on R&D have ranged from 50% to 100%, with private rates of return estimated at about 15-30%. Many analysts have concluded that technological change, more specifically through investment in R&D, has a very significant effect on the rate of national productivity. Indeed, it has been demonstrated that R&D conducted by firms in one sector of the Canadian economy has significant benefits for other sectors.

Recent Initiatives to Meet the Challenge

Suggestions in the past to correct the malaise in private sector R&D have had some impact. Numerous tax incentive schemes that encourage investment in R&D have been put in place, and new experiments are under-way. World product mandates as a partial solution to stimulating foreign-controlled firms' performance of R&D

in Canada have had some measure of success. Targets have been formulated to encourage the private sector percentage of GERD, again with some signs of improvement. Our system for protecting intellectual property has been criticized frequently, and is under review to reflect the dynamic nature of new technologies. Nevertheless, more needs to be done by industry, and, in some cases, jointly with governments, to stimulate private sector investment in science and technology.

For this to occur, the private sector must respond to the challenge. There are signs that this is happening. Business has, in partnership with labour, established the Canadian Labour Market and Productivity Centre to help improve productivity, industrial competitiveness and employment prospects.

Several chemical and petroleum processing firms in Ontario have recently founded the Institute of Chemical Science and Technology with a view to improving the competitiveness of the industry. The forestry industry, in conjunction with governments, has been active in developing research strengths through the establishment of a $6 million pulp and paper centre at the University of British Columbia and a $15 million research facility of the Pulp and Paper Research Institute of Canada at the same university campus.

Several firms have made a mark in the high technology domains, notably in the space and aeronautics field; and considerable leadership has been demonstrated by other firms in several other spheres; including the biotechnology, microelectronics and energy-related sectors. The 1986 outlook for corporate R&D spending as a whole is optimistic with an anticipated increase of 11% over 1985. These are positive signals.

Despite a current preoccupation with small businesses, the significant contribution of multi-nationals to Canada's science and technology effort should not be overlooked. According to a recent Ontario government survey, multinational firms are better than average developers and modifiers of technology, and have strong corporate innovation models and formalized innovation mechanisms.

The encouragement of foreign investment is a priority of both orders of government so as to ensure the removal of impediments for growth, and to create opportunities for the private sector to contribute to maximum economic growth in all parts of Canada.

The procurement mechanism for stimulating technological development is underutilized. The three levels of government annually spend $60 billion in the purchase of goods and services. Procurement policy, including improvements to the contracting-out policy, has significant potential for stimulating the rate of industrial innovation. The study team report on government procurement to the Task Force on Program Review suggests a greater increase of the science and technology activity contracted out by the federal government. As previously noted, however, the matter of procurement is a sensitive issue, and one that must be carefully handled in the current context of technology protectionism and enhanced trade negotiations.

Small businesses, because of their quickness in seizing and developing new markets and their ability to adapt to innovation and changing technologies, offer another strategic element in putting knowledge to work. The development of entrepreneurially-based incubators and metropolitan-based technology councils is a growing phenomenon in this country. Discovery Parks in British Columbia, the Saskatoon Innovation Place, and Sheridan Park in Ontario are examples of the former, while the Calgary Research and Development Authority and the Groupe d'Action pour l'avancement techologique et industriel de la région de Québec (GATIQ) are examples of the latter. The Innovation and Entrepreneurial Management (TIEM) Corporation is an illustration of an entreprise centre concept that involves providing a range of services to small business. Services include technological assessment, improved access to seed capital and facilities to house new businesses. Such centres are now operating in Sydney, St. John's, Québec City, Winnipeg and Vancouver.

Our services sector, particularly that of the consulting engineering industry, constitutes a significant resource. Canada possesses four of the world's 20 largest consulting engineering firms. They are well placed for transfering and diffusing knowledge.

The Economic and Regional Development Agreements with their attendant subsidiary agreements negotiated between the two orders of government represent significant vehicles for stimulating economic growth in partnership with the private sector. Financial commitments under these arrangements total close to $4 billion, over $0.5 billion of which is devoted to encouraging research and development, technology transfer and industrial innovation.

Major challenges remain. For example, how can the science and technology investment base of Canada's corporate sector be broadened? The fact that only 970 out of a total of more than 35,500 manufacturing firms conduct R&D indicates the narrowness of Canada's industrial R&D base. The challenge will be to increase this R&D infrastructure.

How can the partnership between industry and industrial research organizations be expanded? Industry's experimentation with "pre-competitive", generic, applied research organizations is limited; but, there are some effective examples in the pulp and paper, welding, cement, steel, and gas industries. Many of these industrial research organizations have developed strong linkages with universities and government research organizations. With the current reappraisal of government-funded technology centres, the partnership with industry will have to be strengthened.

Canadian industry also has to cope with its own ability to maximize the use of technology - as the Canadian Manufacturers' Association puts it - "as a competitive weapon throughout a broad range of industry." The private sector must commit more investment to technology. As the CMA's recent discussion paper, "Improving Industrial Competitiveness" states:

> "Competitors from industrial countries are improving their own use of technology and competitors from newly-industrialized countries are increasingly using technology in combination with their lower cost base. In short, Canadian companies are in a global technology race."

It may, in fact, be the case, as the Ontario technology transfer study suggests, that many firms do not yet desire new technology. As the authors of the study note, firms may not be convinced that the returns

will be sufficient; they may not feel that they have adequate shop floor skills to make use of the technology, or they may not understand how to manage the change process. In any event, the challenge of increasing the technological sophistication of our business enterprise sector remains, and must be met by industry and governments alike.

Summary of Issues

The focus of this section has been largely on the role of the private sector in putting knowledge to work and exploiting technological opportunities. Past performance has been weak for a number of reasons, but there are now several positive signs that business and industry are responding to the challenge of the global technology race. The case is now being made persuasively in most Western economies that a healthy, domestic, scientific infrastructure is required if a country is to accentuate its technological development. Key questions that must be addressed include:

- **How can Canada target its technology resources in strategic areas so as to maximize the return?**

- **How can the partnership between industry, technological change agents and research organizations be expanded?**

- **What measures are needed to ensure that both traditional sectors and new technology industries deal effectively with the diffusion of new technologies, technology transfer, development, commercialization, financing and market development?**

3. Involving All Canadians and Adapting to Change

With the pace of change in society brought about by technology so rapid, it is essential that a National Science and Technology Policy ensure that Canadians are aware of both the opportunities and problems that might arise. Without a stronger technological capacity in Canada, however, we will be unable to create the wealth and jobs that society expects.

All sectors - government, business, labour and education - have significant responsibilities in preparing society for technological change. Here, the human dimension becomes paramount.

Attitudes to Science and Technology

From a public awareness perspective, it is important to understand how the attentive public views the impact of science and technology on a day-to-day basis. This can be influenced by the media, education, public awareness organizations, the public image of scientists and engineers, and the decisions of elected representatives. The media, of course, have a critical role here. If Canadians are to be sufficiently and properly exposed to the impact of science and technology in their everyday lives, it is, in part, the responsibility of science journalists, writers, editorialists and television commentators. A recent survey conducted for the Association des communicateurs scientifiques du Québec shows some deficiencies in this respect. According to the survey, scientific information and news related to science and technology in the Québec media averaged just over 3% of total coverage in daily newspapers and under 0.5% on television.

Canadians, like most others, have a Janus-like view of the impact of science and technology. On the one hand, they are happy to reap the benefits that science and technology bestow upon them, but are wary of some of the more negative uses made of technology. For example, according to a recent public opinion poll conducted in Québec, the Québécois population feels that scientific and technological developments have had beneficial impacts on material comfort, health and quality of life. By contrast, a majority of the population surveyed feel that scientific developments have had a significantly negative effect on the prospects for world peace.

Technological Change and the Workplace

The Québec attitude survey also serves to highlight another major concern - the employment effects of technological change. The survey concludes that from a long-range perspective, just over 50% believe that technological change will create more jobs than it will eliminate, while 40% state the opposite view. In the medium-term, 26% of those surveyed expressed concern that their jobs could be threatened as a result of technological change.

The debate is far from over. A 1985 study of the Ontario Task Force on Employment and New Technology has found that increasing levels of employment and real

income have been achieved while significant technological change has occured. An ongoing study of the Economic Council of Canada tends to support this line and preliminary findings show that between 1971 and 1981 employment in the high-tech industries grew considerably faster than the average annual growth rate for Canadian industry as a whole. The Economic Council is quick to point out, however, that this trend should be viewed with guarded optimism. Questions of dislocation, new health and safety issues, and distribution of occupations need to be carefully assessed with the technological change. Furthermore, the jury is still out on whether the skill content of technology-affected jobs will be enhanced or eroded. While there is some evidence to suggest that new jobs in the near future will not require significant changes in educational preparation, the rapid pace of technological change will force individuals to learn how to learn. In fact, according to a recent opinion poll of Canadian attitudes to the workplace, the better training of workers was cited as one of the best methods to increase productivity.

In industry, the challenge remains to retain scientists and engineers and to keep them technologically current. The problem of job obsolescence is real, and will become more severe owing to the rapid rate of innovation and general aging of the workforce. In the U.S., for example, Lockheed Corporation has pioneered a unique program, Lending Employees for National Development (LEND), under which scientists and engineers who might otherwise have been laid off are loaned to other companies while retaining their benefits and seniority at the parent company. While Canada has no similar program, the idea of exchange or loan of personnel is an interesting one, and certainly is one mechanism for maximizing the talents of productive individuals.

Preparing management for a more enlightened approach to introducing technology within the business plan is a matter that must be more effectively tackled. Maintaining the vitality of the industry by finding, motivating and retaining productive individuals is a significant management issue. It will require an effective partnership of business, labour and government to deal with these changes. Already, some models exist. The Workplace Innovation Centre established in Manitoba is an example of an innovative initiative devoted to facilitating the adjustment process to technological change. Another case is that of the

Technology Education Project of the Canadian Labour Congress which led to a series of regional workshops and a national conference in February 1986, and identified several issues for collective action. Among these were that the labour movement should reaffirm its commitment to technological change as a priority concern, and that the labour organizations should establish a central bank for technological change information that could be used for various labour movement discussions. Labour Canada has instituted a Technology Impact Research Fund that supports research and demonstration projects on the social and human impact of technological change in the workplace.

A Scientifically-Literate Society

In the long run, other opportunities present themselves in producing a society that is not only comfortable with change, but one which is scientifically-and technologically-literate.

This latter issue has a great deal of currency at the present time in most industrialized nations. In Canada, the Science Council of Canada, in consultation with the Council of Ministers of Education, undertook a major study on the health of science education in our school system. The Science Council's concern was that today's young people are not being adequately prepared to live and work in tomorrow's complex technological society. The Council urged that science education be guaranteed in every elementary school; that girls be encouraged to continue with science and engineering throughout their schooling; that the education show how Canadians have contributed to science and how science has affected Canadian society; and that technology education be introduced in secondary schools. These were some of the major recommendations of the study, and have led, in some instances, to a reappraisal of our science education system. Ultimately, future generations must be better equipped for a technological world.

Several industry and business groups have also expressed their views on this fundamental issue. For example, the Electrical and Electronic Manufacturers Association has released a brief arguing that Canadian society must become more technologically-literate in order that Canada have the trained people to boost Canada's scientific and technological skills.

The Corporate-Higher Education Forum's most recently-sponsored analysis on university graduates and corporate employers also tackles this issue, from the perspective of surveying the reaction of employers to the quality of university education. Generally, the results are positive. However, the report's preliminary findings argue that technical programs should not sacrifice general liberal arts requirements in universities; and that universities, in collaboration with corporations, should expose more technical students to technological innovation and international perspectives.

Summary of Issues

This section has highlighted some of the critical elements of managing change in our society brought about by new technology. Technological change will have some major impacts in the workplace and on employment as a whole. Learning to learn is a major challenge of our day, and all sectors will be responsible for ensuring that Canadians are adequately prepared for technological change. This will require special attention devoted to our public awareness of science and technology programs, as well as strengthening of Canada's science education system. The former puts the focus on the role of science museums, youth science and advancement of science organizations, and popular editions of science magazines and journals. Improving public awareness also means assisting the work force at large and corporate management in coming to grips with the opportunities of technology. Key questions include:

- **What measures need to be taken to enhance the joint collaboration of labour and management in the introduction of new technologies?**

- **How can public awareness vehicles for promoting science and technology be better improved?**

4. Putting a National Science and Technology Policy to Work

The Organization for Economic Co-operation and Development has identified three essential components in pursuing a course of economic renewal through science and technology.

1. Clear focal points must be created for a national technological effort.

2. There must be a solid basis (infrastructure) for accumulating and transmitting knowledge and know-how.

3. There must be an appropriate climate for innovation and entrepreneurship.

As the previous discussion has noted, putting a national strategy to work requires a solid infrastructure for developing and acquiring new knowledge; for putting this knowledge to work and exploiting opportunities; and for managing the impact on society of technological change.

Mobilization of a National Effort

Clear and effective leadership for directing the national technological effort will be necessary. A National Science and Technology Policy, which unites the diverse range of federal and provincial programs and policies affecting innovation and research, will provide this focal point. This policy will need to be directed to several key areas.

Among the fundamental new orientations, Canada needs an integrated program and a capability to target its S&T resources in strategic areas so as to maximize the return. In the area of biotechnology, for example, considerable effort has been devoted to preparing a National Biotechnology Strategy that has brought together Canada's major performers in this strategic technology area through various networks. In order to compete with other nations that have concerted efforts in strategic technologies, Canada must provide an overall framework for the development of other strategic technologies of importance to the country, such as information technologies, advanced materials,opto-electronics, artificial intelligence, remote sensing and new construction technologies.

With a proper assessment and market niche identification, these new technologies can lead to the establishment, as is already underway, of new firms and new industries. This strengthening will also play a vital role in supporting existing resource and manufacturing industries.

Governments, universities and the private sector will have to establish partnerships and define their respective roles in developing our strategic technologies.

Using our Infrastructure

We must also learn to use more effectively what we have in place. Canada's scientific and technological infrastructure represents a significant asset in brainpower. We must strive to mobilize it for national purposes. Fortunately, we have some excellent examples of this concentration already in place. The National Research Council's Industrial Research Assistance Program comprises a vast network of technical resources that, in conjunction with provincial research organizations, university-based technology centres and consulting engineering organizations, provides a much needed technical delivery system to Canada's industrial firms.

Our universities are striving to develop critical mass in certain areas through various joint initiatives and consortia. A well-known model of this is the Canadian Microelectronics Corporation, set up by NSERC to enable Canadian universities to carry out effective research and scholarship in all aspects of integrated circuit design. Other examples include the various co-operative industrial research organizations such as the Pulp and Paper Research Institute of Canada, the Welding Institute of Canada, and the Canadian Steel Industry Research Association. Networking among institutions is a specific objective of the Canadian Institute for Advanced Research. The Institute brings together the talents of Canada's researchers to explore specific projects in fields such as robotics and space research.

These, and other initiatives, are encouraging models of cooperation within our industry and between industry, government and universities that should be encouraged and built upon.

Providing the Necessary Climate

The third major feature necessary for a national thrust in science and technology is the establishment of an appropriate climate for innovation and entrepreneurship. This involves a clear framework for competition and cooperation in industry, judicious regulatory reforms, provision of incentives and support for innovators, and the elimination of institutional, bureaucratic, financial and other impediments that can arrest the development of a healthy entrepreneurial activity within the country.

Key decisions are being made in the areas of trade strategy, tax policy, procurement policies, venture capital assistance and R&D grants. These must be continually monitored and evaluated.

An appropriate mix is necessary to stimulate economic renewal. For instance, the federal government is strengthening the tax incentive and grant support programs for R&D in industry. A combination of tax-based and non-tax support has been tailored to meet the varying needs of small, medium and large-scale industries. The government is aiming for a rationalized, simplified, government-wide system of R&D support. The government is also looking for ways in which current industrial R&D performed by the public sector can be streamlined and made more accessible as well as efficient. Consultation is underway to develop much of this in harmony with the programs and measures of provincial governments so that better co-ordination can result. In addition, MOSST is actively involved in looking at mechanisms that can improve the technology diffusion in this country, and has recently completed an analysis of the situation.

The window available to Canada in establishing a National Science and Technology Policy will not be open for very long. International science and technology activities, in particular, are gradually closing this opportunity. We must act now in marshalling our resources and brainpower in order that Canada may assure its economic renewal. We must collectively develop a vision of Canada's economic place in the world economy, and identify the necessary targets that will mobilize our strategic offensive.

Summary of Issues

This concluding section has reviewed some of Canada's assets in science and technology and suggests an agenda for pooling these strengths under a National Science and Technology Policy framework. Questions that must be addressed include:

- **How can we ensure that the various regions of Canada share the benefits of technology?**

- **What should be the respective roles and responsibilities of governments, the private sector, universities and labour in implementing a National Science and Technology Policy?**

- What value would specific objectives and long-range targets have in guiding the implementation of a National Science and Technology Policy?

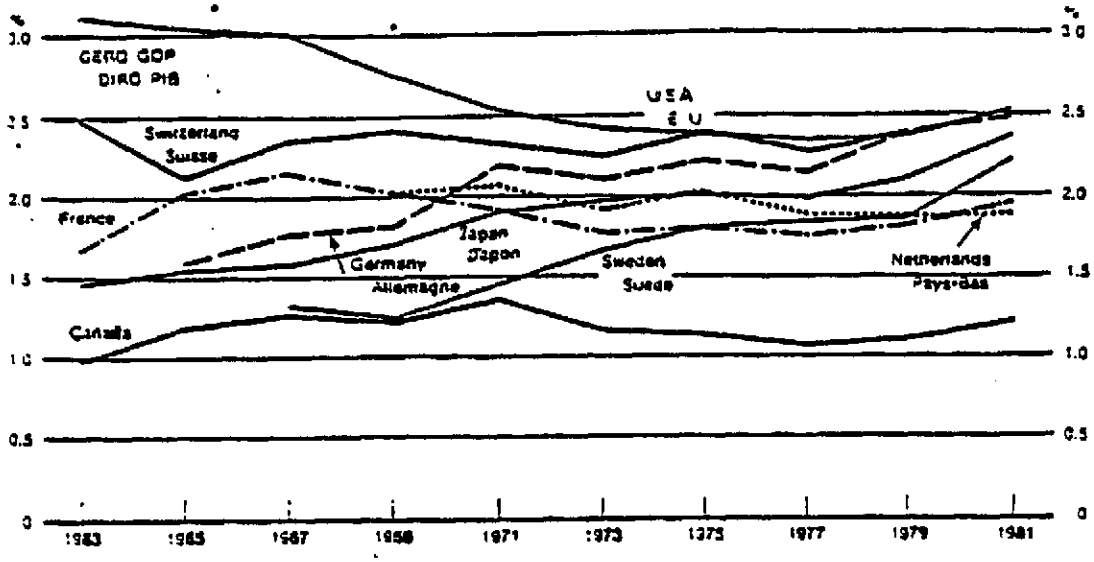
- What are the mechanisms required to ensure continued coordination and collaboration among all parties involved?

APPENDIX A

Selected Statistics of Canada's Science and Technology Activity

Proportion of the Economy Devoted to R&D for Selected OECD Countries, 1963-1981

Proportion de la richesse nationale consacrée à la R-D dans certains pays de l'OCDÉ, 1963-1981



Gross Expenditure on R&D as a Percentage of GDP

	Government Spending	Industry Spending
Canada	.64	.48
Australia	.78	.22
Austria	.51	.58
Finland	.56	.63
France	1.07	.82
Germany	1.04	1.42
Italy	.48	.51
Japan	.64	1.48
Netherlands	.89	.87
Norway	.73	.51
Sweden	.89	1.28
Switzerland	.55	1.72
United Kingdom	1.21	1.02
United States	1.24	1.23

* Source: OECD Selected S&T Indicators. Data are for 1981 except for Switzerland (1979).

Scientists and Engineers (NSE + SSH) Engaged in R&D, in Selected OECD Countries, per 10,000 Persons in the Labour Force

Country	1971	1973	1975	1977	1979	1981
Scientists and engineers						
United States	527,100	518,400	532,700	570,300	621,000	691,400
Japan	247,309	292,097	316,860	331,467	366,998	392,625
Germany	90,206	101,019	103,736	110,972	121,978	128,162
France	60,100	62,700	65,300	67,981	72,889	85,500
Canada	..	21,734	22,960	24,900	26,300	29,670
Netherlands	14,192	14,247	15,460	17,368	18,270	19,436
Sweden	..	12,362	14,759	-	11,760	15,235
Switzerland	8,541	9,854	10,568	11,835	10,720	-
			thousands			
Total labour force						
United States	87,198	91,756	95,955	101,142	107,050	110,315
Japan	51,860	53,260	53,230	54,520	55,960	57,070
Germany	26,910	26,985	26,397	26,074	26,449	27,376
France	21,638	22,083	22,310	22,697	23,059	23,271
Canada	8,727	8,358	10,059	10,578	11,287	11,978
Netherlands	4,793	4,802	4,862	4,877	4,948	5,593
Sweden	3,961	3,977	4,129	4,174	4,268	4,332
Switzerland	3,167	3,203	3,027	2,935	2,972	3,060
			ratio			
Scientists and engineers per 10,000 persons in the labour force						
United States	60.4	56.5	55.5	56.4	58.0	62.0
Japan	47.7	54.8	59.5	60.8	65.6	69.0
Germany	33.5	37.4	39.2	42.6	46.1	47.0
France	27.8	28.4	29.3	30.0	31.6	37.0
Canada	..	23.2	22.8	23.5	23.3	25.0
Netherlands	29.6	29.7	31.8	35.6	36.9	36.0
Sweden	..	31.1	35.7	-	-	35.0
Switzerland	27.0	30.8	34.9	40.3	36.1	-

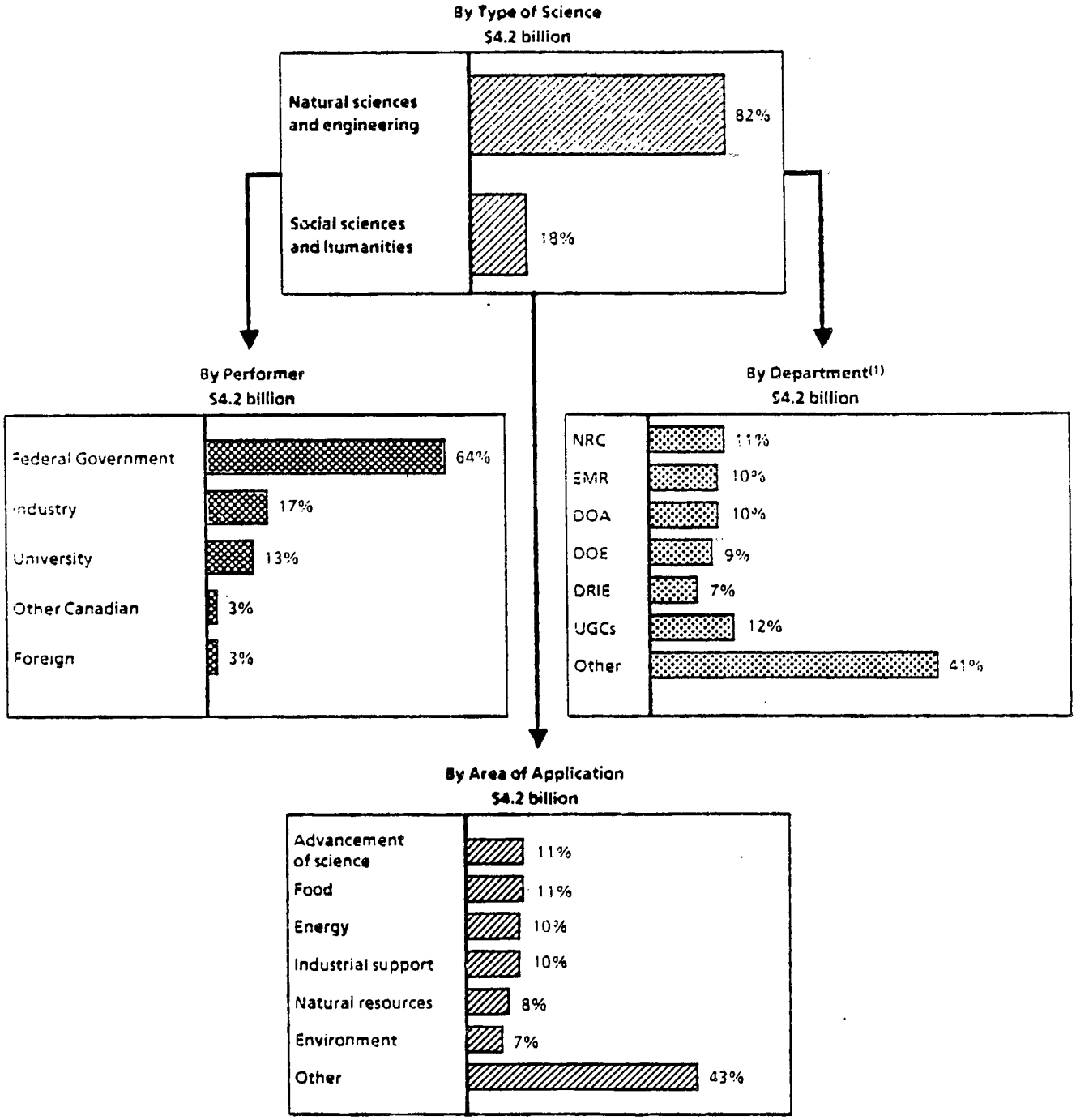
Sources: "Science and Technology Indicators. Basic Statistics Series, Volume C, Total R&D Personnel", OECD DSTI/SPR/82.59, Paris, 1982.
Statistical Yearbook, UNESCO, Paris, 1981 "Labour Force Statistics 1962-1982", OECD, Paris, 1983, p 19.

NATIONAL R&D EXPENDITURES, 1985
(NATURAL SCIENCES, ENGINEERING, SOCIAL SCIENCES & HUMANITIES)
($ MILLIONS)

FUNDERS	PERFORMERS					TOTAL	
	Federal Govt	Provincial Govts	Business Enterprise	Universities	Others*		
Government:							
Federal	1,480	-	303	460	29	2,272	(35.8%)
Provincial	-	165	39	169	68	441	(6.9%)
Total	1,480	165	342	629	97	2,713	(42.7%)
Business Enterprises	-	-	2,446	34	18	2,498	(39.3%)
Universities	-	-	-	701	-	701	(11.0%)
Private Non-Profit	-	-	-	133	36	169	(2.7%)
Foreign	-	-	256	13	-	269	(4.2%)
Total	1,480 (23.3%)	165 (2.6%)	3,044 (47.9%)	1,509 (23.8%)	152 (2.4%)	6,350	(100.0%)

* Others: Private non-profit organizations ($75M) and Provincial Research Organizations ($77M)

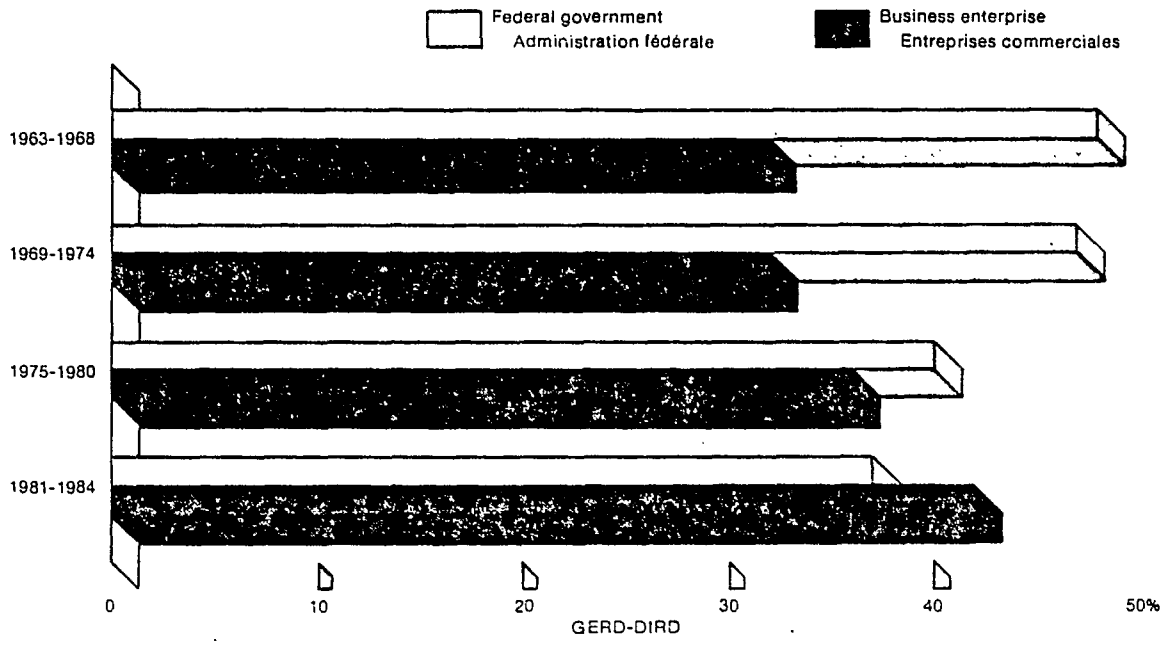
Distribution of Federal Expenditures on Science and Technology, 1985-86



(1) NRC = National Research Council
EMR = Energy, Mines and Resources
DOA = Agriculture
DOE = Environment
DRIE = Regional Industrial Expansion
UGCs = University Granting Councils (total for Medical Research Council, Natural Sciences and Engineering Research Council and Social Sciences and Humanities Research Council)

Federal and Business Enterprise Funding of R&D, 1963-1984

Financement de la R-D par l'administration fédérale et les entreprises commerciales, 1963-1984



Source: Statistics Canada

Federal Expenditures in Support of Post-Secondary Education:[1] Research[2] ($ millions)

	1982-83	1983-84	1984-85
Research Granting Councils[3]			
Natural Sciences and Engineering Research Council	210.8	238.7	260.6
Medical Research Council	106.5	113.9	127.5
Social Sciences and Humanities Research Council[4]	30.8	35.9	37.9
Subtotal Research Granting Councils	348.1	388.5	426.0
Other Departments/Agencies			
National Research Council	25.2	27.2	31.1
Health and Welfare Canada	8.4	8.9	14.5
Secretary of State of Canada	0.0	0.2	9.1
Agriculture Canada	5.9	6.0	7.8
Energy, Mines and Resources	6.7	9.0	7.6
Environment Canada	4.8	7.3	6.5
Department of National Defence	5.0	5.9	5.4
Other	13.2	11.6	15.2
Subtotal Other Departments/Agencies	69.0	76.0	97.1
Total Research Expenditures	417.2	464.5	523.1

1 Source (except as noted): Statistics Canada, Education, Culture and Tourism Division, Survey of Federal Government Expenditures in Support of Education, 1984-85.

2 Includes all research spending except for: a) amounts directed to individuals for education support which are reported as Student Assistance; and, b) administration expenses, which are reported as Other Expenditures, Direct Federal Support.

3 The total post-secondary education spending of the Research Granting Councils has been divided into three categories: Research Support, Student Assistance, and Administration. Only the amounts for Research Support are reported.

4 Source (for 1983-84): Statistics Canada, Science and Technology Statistics Division, Federal Government Expenditure on Activities in the Social Sciences and Humanities, 1970-71 to 1985-86.

Source: Secretary of State

Federal and Provincial Support to Post-Secondary Education in Canada

A Report to Parliament, 1984-85

Balance of Trade in High-Technology
and Other Manufactured Products: 1980, 1984

(Millions of Dollars)

	1980	1984
High Technology	-8,157	-11,974
Medium Technology	-4,628	-6,114
Low Technology	-2,821	-4,453
Resource-Related	13,243	15,262
Motor Vehicles and Parts	-2,661	2,994
Total	-5,024	-4,335

Source: Statistics Canada, Technology and Trade Statistics: Part I, July, 1985.

Canadian Export Market Shares of High R&D Intensity Products: 1970, 1983

(% of Total OECD Exports)

Aerospace	1970	5.9
	1983	3.5
Computers	1970	5.6
	1983	5.8
Electronic Equipment	1970	1.9
	1983	1.8
Telecommunications Equipment	1970	6.8
	1983	3.1
Drugs	1970	2.1
	1983	1.7
Scientific Instruments	1970	3.1
	1983	2.0
Electronic Machinery	1970	1.7
	1983	1.2
Non-Electrical Machinery	1970	10.6
	1983	10.5
Chemicals	1970	0.8
	1983	2.3

Source: OECD - Trade in High-Technology Products, DSTI/SPR/84.66, January 1985

APPENDIX B

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LOWE-MARTIN

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The following section is comprised, in general, of the executive summaries prepared by national associations/organizations in response to the request by the Minister of State for Science and Technology, the Honourable Frank Oberle to provide input to the National Forum on Science and Technology.

While the material is varied, both in content and in format, the national associations/organizations responded to the attached series of questions that correspond to the major themes of the Forum.

All of the material that was provided by the associations/organizations, is available to all participants upon request.

QUESTIONS UPON WHICH YOU MIGHT FOCUS FOR THE FORUM FOR THE DEVELOPMENT OF A NATIONAL SCIENCE AND TECHNOLOGY POLICY

(page numbers refer to enclosed draft paper, "Building On Our Strengths")

Developing and Acquiring New Knowledge (pp. 8-16)

1. In your view or that of your organization or sector,

   a) is Canada getting maximum benefits from money spent on university research? If not, what steps should be taken to improve the situation?

   b) if new money were to become available, should it be used for university research and, if so, how should it be spent to assure maximum benefit to the country?

   c) are you satisfied with the rate of progress toward university-industry cooperation in science and technology? Should it be further encouraged and, if so, how can we foster better linkage between the private sector and universities?

   d) how can your organization help Canada to develop our intellectual capital so that it can be applied to Canada's needs? so that Canada can acquire new knowledge? in the training of highly-qualified personnel?

2. In your view or that of your organization or sector,

   a) is Canada getting maximum benefits from money spent on government laboratories? If not, what steps should be taken to improve the situation?

   b) if new money were to become available, should it be used for government laboratories? and, if so, how should it be spent to assure maximum benefit to the country?

   c) are you satisfied with the rate of progress toward government-industry cooperation in science and technology? Should it be further encouraged and, if so, how can we foster better linkage between the private sector and government laboratories?

3. How could Canada realize more benefits from international science and technology developments? Be more involved in the international S&T networks? In contributing Canadian expertise to international development and cooperation? In recruiting scientists of other countries to share their knowledge in Canada? How can my organization or sector play a greater role in this?

Putting Knowledge to Work and Realizing Opportunities (pp. 17-25)

4. Should Canada target its science and technology resources in a range of strategic areas so as to maximize return? If so, how?

5. What can government do to make sure that Canada's companies are using the best available technologies? What can your organization or sector do to help?

6. What can your organization or sector do to improve methods for diffusing new technologies? Enhancing technology transfer? Making possible development, commercialization, financing, and marketing in all areas of our business sector?

7. By what mechanisms could governments encourage linkages between advanced technology and machinery companies on the one hand, and the existing resource sectors on the other? Why do these linkages seem insufficient at the moment, and what can be done about strengthening them?

8. How could pre-venture capital be fostered and targeted to the high-risk advanced technology industries? What is the provincial role as compared to the federal role?

Adapting to Change (pp. 25-29)

9. What can we do to help Canadians deal with the dramatic sweeping changes in all aspects of life which technological change will confront us with in the next two decades? to develop a new spirit of collaboration instead of confrontation and competition? to ensure that technological change is managed in an intelligent and equitable fashion? to promote greater public awareness of, and participation in, the issues of science and technology?

10. Given market forces, the need for "critical mass", and the tendency of advanced technology businesses to locate in clusters

-- all of which lead to concentration -- what should be done by government and by other sectors to ensure regional balance?

11. What measures need to be taken to enhance the joint collaboration of labour and management in the introduction of new technologies?

Putting a National Science & Technology Strategy to Work (pp. 29-33)

12. In the successful development and implementation of a National Science & Technology Policy, what are the respective roles of the federal government? provincial governments? universities? the private sector? labour? non-governmental organizations? your own organization or sector?

13. What can your organization or sector do to ensure continued coordination and collaboration with all other participants in the effort? Is there a particular mechanism that would make this collaboration more effective? What targets can be set that will guide in the implementation of the policy?

14. Do you have any other suggestions regarding a National Science and Technology Policy and the role to be played by sectors such as your own?

BRIEFS FROM ASSOCIATIONS/ORGANIZATIONS

1. Association des communicateurs scientifiques du Québec
2. Association for the Advancement of Science in Canada
3. Association of Canadian Community Colleges
4. Association of Canadian Universities for Northern Studies
5. Association of Provincial Research Organizations of Canada Inc.
6. Canadian Association of Physicists
7. Canadian Association of University Research Administrators
8. Canadian Association of University Teachers
9. Canadian Chamber of Commerce
10. Canadian Chemical Producers' Association
11. Canadian Council of Professional Engineers
12. Canadian Council of Technicians and Technologists
13. Canadian Federation of Biological Societies
14. Canadian Federation of Independent Business
15. Canadian Labour Congress
16. Canadian Manufacturers Association
17. Canadian Research Management Association
18. Chemical Institute of Canada
19. Corporate-Higher Education Forum
20. Electrical and Electronic Manufacturers Association of Canada
21. Fraser Institute
22. Mining Association of Canada
23. National Consortium of Scientific and Education Societies
24. Pulp and Paper Research Institute of Canada
25. Royal Society of Canada
26. Social Science Federation of Canada

ASSOCIATION DES COMMUNICATEURS SCIENTIFIQUES DU QUÉBEC

The purpose of the Association des communicateurs scientifiques du Québec is to provide opportunities for meetings and exchanges between professional scientific communicators and to promote scientific popularization. The Association's membership includes journalists, public relations people and organizers from both the public and private sectors.

Through its activities, the Association attempts to meet its members' needs for training, development and information. It also seeks to encourage thought on scientific communication practices, and to promote joint action by members and organizations belonging to the popular scientific community, notably by organizing conferences.

Scientific Popularization: A Necessity

Scientific knowledge and technical complexity are the bases of our society's development. They have also transformed our environment. Modern man is somewhat similar to primitive man: surrounded by mysterious phenomena, at the mercy of nature (or high priests), and so on.

From one day to the next, the tools we work with and even the most ordinary objects become more complex. The new and different world emerging around us threatens to become almost completely foreign to us. At the same time, our society must

accelerate the pace of change and create an environment conducive to it. Moreover, such an environment must be ready to accept, understand and steer the course of change, in order not to be its victim.

Despite cultural models which do not always enhance technical knowledge, the desire for knowledge exists, as demonstrated by a number of studies[1] and popular trends (such as computer sciences).

Scientific information circulates everywhere in every form. Too often, however, it exclusively targets a specialized, marginal, or English-speaking public. Or its chief purpose is dictated by marketing or public relations concerns. For this reason, the public was first "educated" about computers through the advertising of micro-computer manufacturers. Although that is not so bad, it is not enough.

To popularize something means to make it available to the greatest number of people. It means heightening awareness and informing. But it also means decoding, taking a critical approach to "the wonderland of science and technology". This approach harmonizes with certain democratic objectives. Sharing power (which is also scientific and technical) and involving the public in social debate (new forms of energy, pollution, the impact of technology on jobs) and decisions, require better means

[1] Tremblay-Roy Report, Ministère de l'Enseignement supérieur de la Science et de la Technologie du Québec, 1985, p. 222.

of disseminating information.

The Current Situation

In this respect, it would appear that the mass media are poorly equipped for the job. A study sponsored by the ACSQ[2] revealed that scientific news, with 3.1% of news space, ranks ninth in major newspapers -- far behind sports (26.4%), politics (15.6%) and the economy (10.6%). Worse yet, it captures only 0.44% of television broadcasting time. Thus, an enormous gap seems to exist between the news content of the mass media and the current scientific and technical reality.

This phenomenon is all the more puzzling given that it does not stem from the public's wishes. In a recent poll taken by the Quebec Federation of Journalists, in co-operation with the magazine L'Actualité, 97.7% of those surveyed said they would like to receive more scientific information.

Despite everything, the vitality of Quebec's popular scientific community surfaces outside the mainstream media in excellent magazines such as Forêt Conservation, Québec-Science, Science et technologie, Interface, Je me petit-débrouille, Franc-Nord, and La Puce à l'oreille, or in the efforts of the Hebdo-science press agency, which publishes books and a magazine in

[2] La nouvelle scientifique dans la presse québécoise, Louise Boucher and Denise Dupuis under the supervision of Bernard Schiele, Association des communicateurs scientifiques du Québec, 1985.

addition to disseminating scientific information to radio stations and regional weeklies.

However, management of these undertakings is tenuous and depends heavily on volunteers. Government subsidies are meagre and fluctuating.

Solutions

The government already sponsors a program intended to heighten public awareness of science and technology which has played a crucial role in the development popular science.

Regrettably, the program's budget was reduced by one-half this year, to $600,000.

Government action, especially with regard to funding, should be re-evaluated according to several priorities:

1. The awareness program's budget should be significantly increased;
2. Funding established popular scientific organizations should take precedence over implementing every "good idea" suggested by organizations without experience in the field;
3. Applications from organizations that intend to gradually decrease their dependence on government support (through consultation and marketing) should take precedence.
4. Youth-oriented activities should be given priority;

5. Training and development activities, and activities aimed at increasing media awareness, should also take priority.

The ACSQ's Role

The ACSQ can play a leading role in organizing the popular scientific community. Its Forum of Scientific Information and Popularization Societies, which has already planned a number of joint marketing measures, could be a particularly useful intermediary.

The ACSQ can contribute to training and developing its members and, in co-operation with other organizations, foster greater awareness among journalists.

In May 1986, the ACSQ will hold an important international conference on scientific popularization. The conference, organized by two major universities with the help of several public and private sector organizations, will analyse the current state of scientific popularization and determine specific policy elements. Its goal thus coincides with that of the present forum.

ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE IN CANADA

EXECUTIVE SUMMARY

Our geography is enough to make Canadian society particularly dependent on applications of science and technology. It is natural, therefore, that our scientific and technological heritage should be rich - a fact few Canadians appreciate.

We in Canada are a society of high spenders on technological products without balancing the books through earnings from the development, production and sale of such products. Our well educated electorate accepts the above imbalance because it has been convinced that we can always balance the books by exporting natural resources. As long as this mindset prevails, there is little basis for an effective national science policy, as has been demonstrated by the difficulties met over the past twenty years in establishing such a policy.

We believe that these difficulties will persist until the public at large embraces science and technology as part of its culture and makes a conceptual transition from the resource-based society of yesterday to a knowledge-based society of today, demanding substantial support for research and development. Over the long term, perhaps over two decades, the implementation of the recommendations in the recent report by the Science Council of Canada on Science Education may change things for the better. But we must also tackle the problem in the short-term.

Recognizing the above, we encourage the Winnipeg Forum to consider two parallel streams of action. In addition to seeking consensus on how to fashion the most appropriate science and technology policy for Canada, the Forum should consider appropriate means for explaining to the Canadian public the importance of S & T in their lives and hence the very need for a science and technology policy.

We have proposed that among the many approaches, two offer the best prospect for success in the near future. One is the development of a large national voluntary association (AASC) with its own magazine (in the first instance Equinox for the English community).The other is to bring together, through the National Museum of Science and Technology, in a cooperative effort, participants from industry, universities and government to tell the story of their common achievements, in all fields of science and technology, just as it is being done for Communications and Space.

Encouragement and support from the participants in this Forum can speed the success of these two initiatives.

ASSOCIATION OF CANADIAN COMMUNITY COLLEGES

A RESPONSE TO

THE MINISTRY OF STATE FOR SCIENCE & TECHNOLOGY

THROUGH

THE ASSOCIATION OF CANADIAN COMMUNITY COLLEGES

ON

THE DRAFT PAPER "BUILDING OUR STRENGTHS" -- A BACKGROUND PAPER FOR THE NATIONAL FORUM ON THE NATIONAL SCIENCE & TECHNOLOGY POLICY

MAY 1986

The Association of Canadian Community Colleges
110 Eglinton Avenue West, Second Floor
Toronto, Ontario M4R 1A3 416/489-5925

THE ASSOCIATION OF CANADIAN COMMUNITY COLLEGES

The Association of Canadian Community Colleges (ACCC) was established in 1970 to serve as the national voice of post secondary public educational institutions offering certificate and diploma programs throughout the country. A bilingual organization, the Association currently has 119 member institutions and a number of associate members.

The Association's Board of Directors includes representatives of trustees, students, faculty members, and administrators. The Association serves not only as a policy development and information sharing organization, but has been particularly active in the fields of Canadian Studies, and International Education, and the interface between Industry and the Associations Members.

The Association of Canadian Community Colleges welcomes this opportunity to present its views on the principles underlying a National Science & Technolgoy Policy. In that the Community Colleges have been the largest component of Canadian post secondary education since 1978, they can be a significant factor in both establishing and implementing a National Science & Technology Policy. The colleges educate, retrain, and upgrade the majority of the Canadian qualified work force, and contributes significantly to the transfer of technology to the work place. Additionally, Colleges & Institutes are a major contributor for the reduction of adult illiteracy in Canada. It is also observed that Institutions and Colleges have a solid track record of translating social and economic policy into action at national and provincial levels. In all, then, the Association and its Members have proven to be responsive public institutions applied in nature, resourceful, adaptable, who are having a national reputation for achievement and excellence.

The ACCC responds to government queries regarding matters of national interest through a process which seeks to develop consensus amongst its

membership. The few weeks between the submission of this document and the Conference which follows in June, with this, be given to insure that the comments set out below are broadened include a more national perspective of the Association's Membership. It will also be noted that the comments in the enclosed brief are set out in point form. It is expected that the concomitant narrative will unfold during the group discussions at the Conference itself.

COMMENTS REGARDING "BUILDING ON OUR STRENGTHS"

1. There is today, and there has been every day for the past two decades, a very real need for a National Science & Technology policy. The present Conservative Government is strongly to be commended for giving their attention to this matter. It is hoped that the Government will quickly and insightfully respond to the comments of their Staff, and to those at the Forum in Winnipeg. The work of previous Commissions and Government sponsored symposia have most often failed to produce meaningful long term results.

2. Any policy established by the government must insure that the Investor or Industry is offered relatively long term direction. It is our experience that up to 14 years may be required to take a new product from the idea stage through to large scale plant production and hence to a profitable sales volume sufficient to offset research and pre-production costs. Thus a three or five year Policy will not suffice. A longer term Policy developed in cooperation with Industry and Education should also do much to reduce the risk-adverse attitude of business; an attitude which has become ingrained through decades of short term or non existent government policies and support systems.

3. There is a growing level of evidence that Colleges and Institutes, to a degree perhaps even surpassing that of Universities, have developed an effective and flexible interface with Business and Industry. The current program through the Ministry of Canada Manpower and Immigration documents, that from coast to coast across Canada, Colleges and Institutes are effectively assisting Industry in implementing new technologies and in training their staff to use them appropriately.

4. We would agree that both Universities and Industry are under funded in their desire to provide more basic research. However, any substantial increase in funding must be tied directly to Regional or National Economic objectives.

5. The predicted requirement for 1600 new researchers at the Ph.D. level, to meet R & D levels of 1.5% should be a long term goal for Canada. However, it is unlikely that many of the 1600 will be "in place" and have their first productive idea before 1995. The short term need thus also has to be accounted for in any Science & Technology Policy, and that requires the government's support of Industry obtaining licencing rights in those instances where new Canadian products or technology are being developed; ie. support has to be given to development projects based on the potential basic ideas of others.

6. The faculty required to teach the growing number of students in high technological fields should principally come from a system which enables them to teach in Institutes and Colleges for it is from the latter that National Institutes and Industry will draw most of their employee requirements. For each R & D employee, with University preparation, one usually has associated with them some two to four support staff who have less formal education than that of a four year degree.

7. There is really little evidence to relate the unsatisfactory economic growth of Canada to declining funds available to Universities for capital expenditures. However, it is true that Universities have experienced an erosion their ability to perform, but it is a separate debate as to whether the consequences of that are good or bad.

8. The formula increase over the next five years, by one billion dollars, by the three granting Councils should be altered to enable colleges and institutes--not just universities--to have more alliances with Industry. Similiarly, the recent announcement by the Federal Government to match private sector contributions for University research also should be able to accommodate the applied research and development that is/can be done through Institutions and Colleges. Often colleges have more quickly obtained new high-tech equipment than have universities, and thus are in a better position to undertake applied research.

9. The Background Paper in several instances, cites the need for the Private Sector to respond to new challenges, and offer the CLMPC as one example or model of where this is happening. It is doubtful that this is indeed the case, nor that it will become a good model. Harmonious inter and intra relations be developed amongst the Council Members and this not likely in Canada over the coming decade. Perhaps one requires an educational process, beginning in the public school system, in which develops a significantly heightened concern for the necessary and ongoing positive relationships between community values; power; social values; and economic needs.

10. The three essential components identified by the OECD, for Canda to pursue a course of economic renewal through Science & Technology, are seen as being very relevant and quite necessary for any National Science & Technology Policy.

11. While a minor comment, there would appear to be a contradiction in the last two sentences of the major paragraph on page 23. On one hand it is stated that ".....new jobs in the near future will not require significant changes in educational preparation.....". The following sentence contains "In fact, according to a recent opinion poll of Canadian attitudes to the workplace, the better training of workers was cited as one of the best methods to increase productivity". The thrust of these two sentences should be clarified before they are debated further. However, regardless of this matter, it is clearly important that a higher percentage of Canadians must become scientifically and technologically literate; as well as having first rate skills in learning-how-to-learn.

12. One can most certainly assign/devise roles for Government, Post Secondary Educational Institutions the Private Sector, and Labour, when approaching the development of a National Science Policy. This is probably not a meaningful activity until, through consultation, the Policy first has been established. An iterative consultative process, with increasingly more decisions being taken by government after each

step, should lead to a good working policy. As one approaches the end of this process the appropriate roles for each of the participating parties then can best be ascertained.

13. Finally, one should have concern that a Government's Draft Paper underlying a Canadain National Science & Technology Policy makes no reference at all to the role of Colleges & Institutes--either positively or negatively. Both groups of institutions are richly staffed with people who have been awarded their positions primarily because of their work in the applied areas of Science & Technology. It is the application of new ideas or high technology that will be a benefit to Canada; as will the training of those who will be working directly with the sophisticated equipment and machinery in the laboratories, pilot plants, along the production lines. The ACCC would recommend that, the National Forum take account of the 50% of post secondary staff and students who have chosen not to attend University, or who have come from Universities to obtain practical skills.

ASSOCIATION OF CANADIAN UNIVERSITIES FOR NORTHERN STUDIES

Submission to the Hon. Frank Oberle,

Minister of State for Science and Technology

THE NORTH IN A NATIONAL SCIENCE AND TECHNOLOGY POLICY

Minister:

The Association of Canadian Universities for Northern Studies (ACUNS) is an organization of thirty-five Canadian universities (Appendix A) devoted to "the advancement of northern scholarship through education, professional and scientific training, and research". More specifically, the mission of ACUNS is:

> To represent the interests of member universities by influencing government and private sector policies and practices related to the support of northern scholarship.
>
> To establish mechanisms through which resources can be allocated to member universities and northern scholars for the purpose of increasing knowledge of the north and ensuring an appropriate number of trained and skilled northern scientists, managers, and educators.
>
> To enhance opportunities for northern people to become leaders and promoters of excellence in education and research matters important to northern society.
>
> To facilitate through conferences, seminars, research and other methods, the understanding and resolution of northern issues.
>
> To co-operate with other public, private and international agencies and organizations concerned with the advancement, application and impact of northern scholarship.

Clearly, "Science and Technology", however defined, are important parts of this mandate.

In many ways, the Association is typical of Canadian attempts at capitalizing on strengths and minimizing weaknesses of the organization of universities in Confederation. It is remarkable that today thirty-five of Canada's universities have more or less formal structures for dealing with northern (or better, polar) education and research. These structures include institutes such as the Arctic Institute of North America (Calgary), the Boreal Institute for Northern Studies (Alberta), and the Labrador Institute of Northern Studies (Memorial), and Centres such as le Centre d'études nordiques (Laval), and the Centre for Northern Studies and Research (McGill) as well as a variety of less formal (but not necessarily less effective for that), organizations such as those at Queen's, Toronto, Université du Québec à Chicoutimi, Saskatchewan, U.B.C., etc. In addition to the multi-disciplinary focus of "northern studies", which includes a substantial representation of science and technology, our universities are associated in various ways with a number of more specialized science and technology organizations which deal with the polar regions. These include C-CORE (Centre for Cold Ocean Resources Engineering), C-FER (Centre for Frontier Engineering Research), NHRI (National

Hydrology Research Institute), at Memorial, Alberta and Saskatchewan respectively, and specialized groups such as the Northern Medical Unit, Manitoba, the Eastern Arctic Teacher Education Program, etc. Our universities have northern field stations, laboratories and archival and library resources. We also have member universities which operate in relatively isolated northern areas and many more which conduct distance education and other teaching programs in northern areas. Although ACUNS does not claim to represent all of these organizations here, it does consider its mandate as involving the areas of academic activity which they represent and those of thousands of faculty and students directly and indirectly involved with northern education and research. It also, as its terms of reference indicate, considers that part of its mandate is to carry Northern Studies to those yet untouched by them.

Canada's strength in academic northern work lies in the extraordinary diversity of activity at our thirty-five member universities. The national weaknesses in this field of endeavour include the "balkanization" of effort (your background paper and Symons 1984) which is apparent from my last paragraph. The universities set up ACUNS almost ten years ago to cope with this matter. It is still necessary to write a long paragraph in order to convey any impression of Canada's strength in this area of teaching and research, but at least today, someone can write it. And, of course, the knowledge necessary to provide an overview of strengths also allows the identification of weaknesses.

There must, surely, be scores if not hundreds of organizations like ACUNS designed to cope with the advantages and disadvantages of Confederation in education and research. But ACUNS is very different from most of these in that it directs its attention not only towards some sort of a subset of knowledge but also towards a distinctive and very large proportion of the country and of the globe. We do not argue that, say Science and Technology in the North are unique but rather that conditions in the North, human and physical, are sufficiently different to merit special attention and organization. We believe for example, the practice of science in the North will often require a multi-disciplinary perspective and a particular awareness of the human sciences and special ethical principles.

While taking the "universal" view of science, we have little difficulty in accepting the idea of focussing national energies for the furtherance of that science. Our general concern for the North also helps us to easily grasp the idea of Technology which has a characteristically "Canadian" dimension.

More pragmatically, we see ourselves as contributing to the proper management of Canada's North, that is most of the national territory including the north of the provinces and the Territories, which at this point in time have a very limited science base. Neither of the Territories has a university of its own although both are developing science institutes. Because of its involvement with the Territories, ACUNS is a truly "national" body in the sense envisaged by your background paper with its desire for a <u>national</u> Science and Technology policy.

We see Canada as a nation which, after more than a century of Confederation, has at least come to terms with the practicalities of life in the south (which many non-Canadians, of course, think of as the north) but

which has yet to come to terms with its national and global responsibility in the North. Each Canadian is responsible for more real estate than almost any other nation on earth but most of that real estate is "northern" by most measures. We would be shirking our responsibility as a rich developed nation if we did not deliberately focus a good measure of our science and technology energies with this in mind. Also, we submit, like T.H.B. Symons (1973), that such a focussing will result in a more worthwhile Canadian contribution to universal science as in general it is healthy to address problems on one's own doorstep. Canadians are more likely to contribute to mainstream science through the study of polar bears that the study of camels. This is even more self-evident in Technology than in science. The nature of Canada presents both opportunities (e.g. the polar bears) and responsibilities (e.g., again, the polar bears).

The North is a national responsibility. We owe it to the people of the North and to the global community to develop a competence in aspects of Science and Technology which relate to that North. Inasmuch as "northern" science and technology is simply cold weather science and technology, developing that competence is also enlightened self-interest for a country like Canada.

We also argue that the Canadian North represents a special trust which Canada has to the global community. As a relatively small nation managing a large proportion of the globe's land and sea, it behooves us to make the maximum possible use of polar science and technology developed abroad. Not only must Canadian work be effectively passed into the mainstream, we must also make maximum possible use of the huge amount of information available from south polar and north polar work undertaken by other countries. At the present time we have no systematic means of tapping this as a nation. We lack both a focus and network for our own northern information and a national centre which is capable of funnelling in the results of polar work from other countries.

ACUNS is a national university organization and, although we work closely with native groups, the private sector, the provincial governments, the federal government and the Territories, we cannot pretend to represent all "national" science and technology with respect to the North. In our brief on the National Polar Institute (submitted to Hon. David Crombie, 1986), we have, for example, expressed concern with the flow of information in the North between these various areas of national life. Similarly, although we are paying increasing attention to international polar affairs, we do not have the resources to be the national focus for this.

The Arctic Science Act passed by the U.S. Congress in 1984 (Appendix B) is an interesting example of a pragmatic approach to northern science and technology.

The Act mandates an Arctic Research Plan which all U.S. federal agencies must be in compliance with. The National Science Foundation is the lead agency for developing a plan by June 1987.

Background documentation (see Polar Research Board, 1985) identifies the following fields for particular attention: Upper atmosphere and near-earth space physics, Atmosphere sciences, Physical and chemical oceanography, Marine

life sciences, Glaciology and hydrology, Geology and geophysics, Permafrost research, Arctic engineering, Terrestrial and freshwater biology, Medicine and human biology, Social and cultural research, and Economics.

An extremely important part of the plan is the design of a national arctic information network for the U.S.A. (see Sokolov, 1985). The network's purpose is to increase research efficiency and assist decision making by allowing a user, anywhere in the U.S., to ascertain whether information on a particular arctic topic exists and if so, how and where to obtain it. The network is to be designed for a variety of users, not only researchers. It will include "library" and non-library (e.g. digital) information.

The aim is to link existing information systems into a whole, strengthening and filling gaps where necessary. These last indicate the strategic benefits (to, for example, Science and Technology) of an exercise such as this.

Canada has a remarkably large number of very effective polar information systems which are loosely represented by the Northern and Offshore Information Resources group (see ACUNS, 1986 (in prep.)). But we are again faced with thestrengths and weaknesses of "balkanization". None of the systems can claim to be comprehensive and efforts to forge links between them have barely begun. In some ways, of course, the situation in the U.S. is simpler in that the Americans have only one major jurisdiction for their own Arctic work, Alaska, while all of their other polar work, including the huge effort in the Antarctic, is essentially 'national' in character. Also the Library of Congress has an entirely global mandate, so that, for example, it collects and disseminates Soviet Arctic and Antarctic material as a matter of course. By contrast, our 'North' directly involves the Territories, all but three provinces and all major federal ministries. Our national libraries have a very limited mandate in terms of international polar work.

The U.S. Arctic Science Act can be interpreted as an effort to counter-balance the huge Antarctic effort of the United States in recent decades. It is a deliberate attempt to move cold region science back into the northern hemisphere. Both the United States and the U.S.S.R., the main players in cold region science, have focussed great energies in the Antarctic in recent decades. Indeed the Antarctic is, in many ways, the major source of cold weather science and technology today. Canada is the only developed nation which has yet to sign the Antarctic Treaty.

Canada, with its extremely diverse northern jurisdictions and interests, badly needs a truly national northern information system. We would also benefit more than most from a linked international system. It is not beyond the bounds of possibility, if we could solve the internal problems of 'balkanization', that we could become the linchpin of such a system. Perhaps here, as in other ways, the existence of and responsibility for the North could stimulate us to undertake an exercise which would benefit the whole nation? Perhaps this exercise could begin with Science and Technology?

Your background paper raises the matter of science education. ACUNS, like other university organizations, is deeply concerned with both education and research insofar as they can be separated. While in the early years of our existence we were perhaps more concerned with quantity in northern

studies, today we are greatly concerned with quality. Without overstating the scale of effort possible by a small association, we have tried to stimulate interest in northern topics in schools, colleges as well as the universities. Tens of thousands of university students are today exposed to "northern studies" somewhere in their courses. We see it as important that science and technology students are not only exposed to northern content in their disciplines but also to northern work from other disciplines, within and outside science. It is simply not possible today to undertake good science research or to properly apply science in the North without great awareness of and sensitivity for the special social, political and environmental features of the polar regions.

An indication of the current level of university activity in the North is that more than three hundred university students undertake more or less independent research in the North each year under a single grants program. This is the Northern Scientific Training Program of Indian and Northern Affairs which is specifically designed to support the training of young scholars (for further details see Northline/Point Nord, Vol. 5, No. 4, October 1985 and reports of the Program). We estimate that the number of students in this program could easily be multiplied by three to represent the total number of Canadian and foreign university students working in one way or another in the Canadian North. As mentioned above, we are now organizing a National Student Conference on Northern Studies to identify the best of these young scholars and to establish personal networks between them.

We would, with deference, like to make some special points with respect to science education or better with respect to science and education in the North. While the north of the provinces is increasingly well served by colleges and universities, the Northwest Territories and the Yukon are at relatively early stages in the development of their educational systems, particularly with respect to science. And yet these Territories are already the focus of a very substantial research effort in both the physical and social sciences. Private sector, government and university research programs there are all very large.

We would be glad to do all that we can to focus the science resources in the North linking, for example, high school, satellite and other courses, visiting scientists and students, federal and territorial science officials, private sector science workers, field stations, etc. in each region. Here, as elsewhere, the science community extends beyond the sphere of professional researchers and science managers. In the thinly populated regions of the North, even less than in Canada as a whole, we simply can't afford to fritter away such resources.

At our recent annual meetings in Yellowknife, it was continually expressed to us that the people of the North want, indeed now insist, on an educational component for all science activities in their territory. They want to be fully informed about projects before they begin, while they are in operation, and on completion they want the results returned to them in published form. They want northerners involved in scientific projects in every possible way. It is interesting to translate this point of view to the national perspective of your background paper. Can we afford to take less than full advantage of work undertaken in Canada by foreign scientists? Are we taking full educational advantage of the work of our own scientists?

The people of the North, being remarkably conscious of the global significance of their concerns (for example migratory mammals, environmental impacts on permafrost and sea ice) want to be tuned in to national and international "knowhow". People in the Mackenzie for example, want to know about caribou work in Quebec and in the U.S.S.R. Again surely there is a message for the nation as a whole.

The people of the North can certainly speak for themselves in these matters. We make these points as an association of universities which has a special debt to northerners and as an association which contains many northern students and faculty.

We also include in our universities many native students and faculty, northerners and non-northerners. The N.W.T., a region of special concern to us, is the last jurisdiction in North America where natives are a clear majority. Again at our meetings in Yellowknife, and elsewhere, special needs of native peoples and their special contributions to knowledge were stressed. In terms of Science and Technology, we would make two broad points. One is that special efforts must continue to be made to improve science education in the native community. Their particular medical and environmental concerns are good illustrations of the real need here. Also, Canada must make a real effort to tap the traditional knowledge (in this case in science and technology) of the various native groups. Some work on ethnobotany and medicine and in environmental research, involving cooperation between hunters and trappers and conventional scientists, has already illustrated the value of this approach. We urge that Canada not ignore this resource, especially for the North.

Thus, Minister, we urge that any articulation of a national policy for Science and Technology implicitly and explicitly recognize that Canada is a polar nation and that her Science and Technology should reflect that fact. This would be a clear recognition of our global responsibility and would be in the best interests of the nation.

The existence of the Canadian North has already had the effect of bringing together, in organizations within individual universities and in ACUNS, scholars from diverse disciplines in thirty-five diverse universities. Perhaps now it can provide one useful, tangible, focus for a national strategy in higher education and research which in the long run is the only firm basis for a national policy on Science and Technology.

W. Peter Adams
Executive Director
May 13, 1986

ASSOCIATION OF PROVINCIAL RESEARCH ORGANIZATIONS OF CANADA INC.

The Association of Provincial Research Organizations of Canada Inc. (APRO) and the Development of a National Science and Technology Policy

DEVELOPING AND ACQUIRING NEW KNOWLEDGE

THE UNIVERSITIES

The one and foremost important mandate of our educational system for all post secondary institutions is and should remain the education and training of highly qualified individuals. The accent on the innovation process whether from a scientific, technical or managerial point of view should be emphasized in all education programs so as to build a strong pool of researchers and modify attitudes towards technological changes. Public awareness will never be attained if our future labour and management are not at ease with those changes.

University research is an important aspect of Canada's science and technology challenge although it would be better exploited if targetted. To ensure better use of money available, grants should be awarded in the two (2) following areas of research:
- long-term, free research executed by excellence centers;
- projects with a strong technology transfer orientation.

Although technology transfer is seeked through the University-Industry cooperation system, very little is actually undertaken mostly because of slow response from University to the needs of Small and medium size entreprises(SME). Slow process of obtaining ecomonic results can be easily coped with by large companies. SME's cannot support this. To facilitate transfer of University research to SME, the following recommendations are suggested to achieve better understanding among research suppliers and consumers:
- professors that are engaged in short or mid term research should be discharged from their academic responsabilities and work in close communication with organizations such as PROs which are the closest link to SME's needs;
- strenghten the receiving programs most PROs have already set up for students and professors in sabbatical leave;
- strenghten the University-Industry cooperation by including PROs as catalysts thus putting to good use PRO's experience with both the industry and the academic communities.

GOVERNMENT LABORATORIES

Many resources and skills are already available although sometimes underutilized. Better use of such resources can be obtained through the implementation of policies such as the ones recommended by the "Tehcnology center study" and the "Nielsen report".

Financing would thus be granted to performing excellence centers in accordance to fields of priority. Laboratories that are mandated to render external services to industry, should make sure that their operation is conducted in a business-like model in respect with the existing network of local, regional and provincial establishments.

Better access to government research skills and resources by industry, especially SME, can be brought about by the existing APRO network.

PUTTING KNOWLEDGE TO WORK AND REALIZING OPPORTUNITIES

TECHNOLOGY TRANSFER

Transfer and application of existing state-of-the-art technology, whether from foreign or domestic origin, to SME is already the role of the PROs. The model created by Germany in the establishment of the Fraunhofer-Gesellschaft Institute is ripe for implementation in Canada. APRO members have strong links with local Universities, government laboratories, National Research Council, private consultants, local, regional, national anf international laboratories as well as with industry associations. APRO should continue to be the lead Canadian group in the transfer of technology to SME but it's role should be expanded and officialized to ensure the greatest benefit to the Canadian economy.

To be such a leader, APRO requires governmental financial support for specific core research activities leading to technology transfer. It is a fact that to transfer technology one has to be able to find, understand and adapt it to different needs before thinking of transfer.

TARGETTING SCIENCE AND TECHNOLOGY

All industrialized nations have at some point in time, focussed their efforts in strategic fields of technology. Canada should urgently identify strategic areas of interest, determine the role to be played by each level of Canada's science and technology network in the areas chosen and develop a 5 to 10 year program accordingly.

ADAPTING TO CHANGE

PUBLIC AWARENESS

Public awareness will never be attained if our labour and management are not at ease with technological change. Some measures to address this issue include:

- heavy emphasis in the educational system on training and retraining is a must;
- heavy emphasis in our educational programs on the importance of technology;
- a system of rewards and penalties for companies and labour organizations so as to encourage retraining in new technical fields;
- a better communication between management and labour about the introduction of new technologies.

PROs can play an important role in this sensibilization process by its technology demonstration and training activities for SME.

REGIONAL BALANCE

Although market forces strongly favor disparities, government could ensure a better distribution of technological wealth by fostering adequate and efficient communication links within the Science and Technology Community as well as ensuring decentralization of new technological initiatives according to regional and provincial priorities.

PUTTING A NATIONAL SCIENCE AND TECHNOLOGY STRATEGY TO WORK

PROVINCIAL GOVERNMENTS

The role of provincial governments should be to:
- establish provincial/regional priorities;
- provide infrastructural support, including tax incentives and grants, to support those priorities;
- negociate with the federal government concerning national and regional priorities;
- support research and technology transfer of provincial interest;
- adapt educational policies to take technological changes into account.

FEDERAL GOVERNMENT

The role of the federal government should include:
-the establishment, in conjunction with industry and the provinces, of national goals in science and technology with due attention to the issue of available resources and skills;
- the establishment of infrastructural assistance for export marketing, national standards, personnel retraining, science and technology information network as well as incentives through fiscal policies and, where necessary, grants;
- the establishment of policies to lessen future regional disparities;
- the support of research and technology transfer of national interest.

THE PRIVATE SECTOR

All actors of this economic force should participate by:
- precisely articulate their needs for particular science and technology subjects;
- increase their communication with the labour force and motivate training and retraining;
- participate more actively in the risks of technological implementation.

LABOUR

Labour has as important a role to play in this policy as the other partners . In accepting that technological changes will increase , labour must participate by retraining and adaptating the work place to the coming changes.

APRO

The Association of Provincial Research Organizations of Canada Inc. (APRO) groups institutions located in eight provinces, with common goal to satisfy Canadian industrial needs in research and development, technical services and information. Grant aided by provincial administrations, APRO offers infrastructures and professionnal skills accessible to all Canadian industries and especially SME. APRO represents a force for technology transfer with its 2 200 employees (1 400 engineers, scientists and technicians), an annual budget of 125M$ and over 5 000 contracts per year.

APRO's contribution to the science and technology strategy can be presented as follows:
- as a catalyst between university and industry for better technology transfer;
- as a multiplicator for the rendering of services by the government laboratories;
- as a key institution for the diffusion, demonstration and adaptation of technology.

APRO's members are willing and available to participate in the coordination of the short-term implementation of a national policy for science and technology.

FACTORS OF IMPORTANCE FOR THE SCIENCE AND TECHNOLOGY POLICY

It is worth to know that R&D needs expressed by SME are much more tied up to the development and technical services field than to applied research. Requests formulated by SME are often a question of survival that merits particular and immediate attention for the implementation of a solution up to the follow-up in the production line. Ninety percent of R&D jobs performed for SME imply costs of less than 25 000$.

Although SME play an important role in the Canadian economy, a successful national policy will have to recognize the critical role of both large and small industry. Although SME have great job creation potential, much of the SME's role is as a supplier to large industry. Because of this interrelation, the national policy will have to address both SME and large industry.

CANADIAN ASSOCIATION OF PHYSICISTS

Paper presented on behalf of the Canadian Association of Physicists in relation to the development of a National Science and Technology Policy[+]

J.S.C. McKee, Vice-President, C.A.P.

(Numbered paragraphs correspond to those in the question paper provided)

1. In relation to the development and acquisition of new knowledge, several points should be made:-

a.) There are many reasons as to why Canada may not be getting maximum benefit from University research. On occasion a research group is below critical size and is not truly competitive. In others the research area is not clearly enough defined as a frontier for new knowledge. Most important however is the fact that both Provincial and Federal Governments fail to take advantage of the large pool of technical expertise available in Canada when expert advice, design or technical innovation is required. National and Provincial Directories of successful researchers and their areas of expertise are urgently required, as is the need for Government to foster and access the scientific knowledge and techniques available in this country.

b.) Without additional funds for basic research at Universities, there can be no sound technological future for Canada. On only two recorded occasions has history shown a new technology to have preceded the fundamental science on which it is based -- these being Watt's discovery of the steam engine 100 years prior to Clausius statement of the second law of thermodynamics, and Shannon's development of Information Theory. In all other recorded instances the science

has preceded the technology, usually by a minimum of twenty-five years development time.

As investment in basic research is to some extent always an act of faith, and recipes for funding it difficult to derive. I append a short discussion of this topic which appeared in Canadian Research several years ago, and commend its philosophy (see 'Death of a Sacred Cow' - attached).

Continuing and developing investment in fundamental science ensures that our most able minds will have an operational base in this country, and form a body of active research scientists who not only understand and appreciate new technologies as they develop but also ensure a Canadian presence in new and developing fields as they emerge.

When funds are limited, successful research groups should still be supported. In the leanest times one should still invest in success.

c.) Where University-Industry Cooperation is concerned, a new kind of University Open House can prove valuable. In this, the University does not open its doors to potential undergraduates in the traditional manner, but rather opens its research laboratories to Government and Industry, by means of ticket-only invitation. Such public communication has proved invaluable to technological development in several European countries in recent years, and this model seems appropriate for relating University researchers in Canada directly to the Private Sector, both locally and Nationally.

d.) The CAP can help to develop the intellectual capital in Canada through organizing Conferences with its Corporate Members, holding forums focussed on particular physics/industry interfaces, and through the priorization of new scientific projects within particular Divisions of its membership. It should

play a more active role in these areas than previously was the case.

2. a.) Government laboratories have an important role to play in certain areas of industry-related research, development and service, and in developing a National monitoring and analysis function. They should not be overly centralized, or geographically isolated from other researchers in related fields. Secure industrial research may best be carried out at Government laboratories.

6. The CAP draws attention to problems in promoting enhanced technology transfer. The most successful partnerships between University and Industry arise when a University researcher requires a unique product from Industry and basically pays the development cost through his Federal or other research grant. Industry then builds a market on the basis of the new technique or instrument it has now developed. Rarely does Industry come to the University to take advantage of its expertise and instrumentation. That is why the suggestion made in 1 c.) is appropriate, as is the Directory proposed in 1 a.).

. . .

9. In order that ordinary Canadians can function effectively in a changing technological environment, education at all levels is an essential component. Informed scientific journals written at a lay level; television and radio programming, and new-style science centres where hands-on interactive science can live and prosper, all have an important and indeed essential role to play. Science teaching in the schools, and at University has never been more necessary than today and should form an essential component of any modern day curriculum.

12. The role of Federal and Provincial Governments should be to provide an environment within which research at Universities can prosper. Much of the

research and some of the development will and should be carried out at Universities, whose main value to the Private Sector will continue to lie in the production of skilled manpower for industry.

. . .

13. The CAP welcomes the introduction of vehicles such as ASTRA, the Association of Science and Technology-Related Associations (Manitoba), which can relate professional and industry related organizations together in a forward-looking model. Such a body when seen as sounding board for new ideas can be invaluable to both Government and Industry, and deserves continuing support. CAP is happy to be a founding member of ASTRA.

14. Associations such as the CAP should be encouraged to foster increased awareness of the impact of science (in this case physics) and related technologies upon society in general. It can make its members more aware of the potential applications of pure research and of the importance of the interface with applied science and technology. It can also encourage its members in the acquisition of Canadian patents for appropriate techniques and instruments initiated or developed by its members.

J.S.C. McKee,
Vice-President,
Canadian Association of Physicists.

+This paper at present reflects only the views of the author. It will however be presented to the upcoming meeting of the CAP Council in June 1986 with request for retroactive approval.

CANADIAN ASSOCIATION OF UNIVERSITY RESEARCH ADMINISTRATORS

The Canadian Association of University Research Administrators

(CAURA)

Statement to the Canadian Forum on a National Science and Technology Policy, Winnipeg, June 8-10, 1986.

The membership of CAURA consists of three categories of research administrators: 1) directors and administrators of offices of research grants, contracts and services who are engaged in administering external, as well as internal, research funds; 2) technology transfer officers, who are concerned with research relations with the private sector, patenting and copyrighting intellectual property and with commercializing university discoveries and research; senior university research executives (Vice-Presidents [Vice-Princiapls, Vice-Rectors], Associate or Assistant Vice-Presidents, Deans and Directors) specifically concerned with university research and with research policy in all their dimensions. While the official university response to federal initiatives must come from the Association of Universities and Colleges of Canada (AUCC), which is the collectivity of university presidents, CAURA is uniquely qualified to present the viewpoint of those directly involved with the management and funding of university-based research.

At the recent CAURA meetings at the University of British Columbia (May 11-13, 1986), senior research executives of the major Canadian research universities participated in a vigorous and far reaching discussion of the proposal contained in Mr. Wilson's February budget with respect to a program for federal government matching of private sector contributions to the research councils in support of university research. The purpose of the CAURA discussion was to reach consensus as to the conditions that would induce the universities to participate actively in such a program. The present position paper will outline potential problems that might discourage many universities

from participating actively and outlines alternative models that would doubtless prove to be acceptable to them.

This paper will not present a detailed proposal with definitions of private sector, incremental funding, research and so on. We would be happy to help provide definitions for these contentious terms, if called upon to do so. Nor shall we insist on what many industry and university people have pointed out, namely that were the Government deliberately to have opted for a program that would shift the responsibility for funding the basic scientific, engineering and scholarly research to the shoulders of others it might well have come up with a scheme such as this one. Nor shall we present a detailed alternative proposal in which we spell out incentives to be offered to the private sector or the universities; again, we would be happy to do so if our advice is sought.

On the other hand, we shall not forbear to point out that even were industry to make the maximum contributions envisaged by this proposal and the Government to make the maximum yearly matching grants to the Councils over the next five years, the amounts available to the Councils will scarcely be greater than their present budgets in 1986 dollars and far from those required to fund the five year plans of the three Councils; given the expected rise in cost of equipment and supplies, the budgets of the three research councils at the end of the five year period (1990-91) will be significantly lower in real dollars than in 1986-7 even with the maximum private sector contributions and matching dollars.

Before considering the central issue, that is the conditions under which the universities of Canada would be likely to cooperate in the Government's matching grants program, one other point must be made. When the present government was in opposition, it quite correctly insisted on the need to increase greatly the Canadian commitment to research and development in order to assure the economic future of the country and a sound Canadian presence in the advanced technology sector. Mr. Mulroney put it well: "The starting line for me is the technological dimension. Either we go into the game and become important players in this major league or we become a nation that will, during its entire lifetime, play in the Junior B circuit. To play with the majors, we must make a firm commitment to double the public and private funds allocated to research and development before 1985. Research and development, and the resulting innovations, are the lifeblood of a successfull economy and country." (Chapter IV, Research and Development, p.39, "Where I stand").

CAURA recognizes the need for financial restraint in view of the crushing accumulated federal deficit. Nevertheless, it is evident that research is not a luxury to be indulged in only when times are good; on the contrary, a country that neglects research and development in tough economic times has been likened to a primitive society that consumes its seed corn in times of famine. Our view is that the Government ought to find the means to support the five year plans of the three federal granting councils. Adequate support of the research and manpower programs of the Councils is an essential investment in and for the future of our country.

Turning to the proposal to match private sector contributions to university research sponsored by the Councils, CAURA reached a clear consensus on the following points:

1. The matching program might present grave dangers both to the universities and to the three Councils, depending on the rules that the Government imposes and about which we have no information at the time of writing. Some of these putative dangers are:

a) a shift in focus of the Councils away from emphasis on support of basic scientific, engineering and scholarly research to narrowly applied research and development generating proprietary information helpful to a particular industry or business in exchange for a contribution to the Council in question. The Universities will oppose any measures that might lead to such a transformation of the Councils since support of basic research must remain their function; applied R&D depends squarely on adequate funding of fundamental research, a lesson ignored by a nation at its peril.

b) A destructive competition among Councils for gifts from industry, with a probable inability of one or other councils to secure a reasonable share of industrial and other private sector funding.

c) Interference with traditional university fund-raising activities in the private sector and with the usual university-based contract research for industry and business. In particular, the universities

will resist introduction of contract-type research masquerading as grants to be awarded by the Councils as well as any possible interference or unfair competition with fund-raising activities in the private sector for support of unrestricted and specific university projects.

In view of these, and other, signposts to danger, or frustrations, CAURA would prefer to see the government offer incentives to persuade Canadian industry and business to invest in research likely to be of direct benefit to them rather than to have to attempt to induce them to support the basic research which they and we know to be the responsibility of the federal government. CAURA takes the position that the Government should commit itself to funding both the projected industrial contributions through 1990-1 as well its projected matching contributions and to use its considerable powers of fiscal persuasion to pressure industry into performing the kind of research it ought really to be sponsoring - that directly related to its own needs; such research can not and must not become part of the mandate of the granting councils. The Government is wise in its wish to persuade industry and business to invest more heavily in research but it is not clear how an industry that is reluctant to commit itself to applied research of direct relevance to its own welfare can be persuaded to invest in Council-sponsored university research.

If the Government retains the present plan of matching private sector investment in university research, we believe that the universities, despite the serious

reservations expressed above and despite our perception that it is probable that our efforts may be in vain, will do their best to cooperate and to try to make the program work provided that the principal function of the granting councils to support basic research is respected and that the dangers referred to are avoided in the implementation.

Here are three models that avoid these pitfalls and which would permit cooperation of the universities.

1. All private sector grants, contracts and gifts, in cash or in kind, in support of university research would be directed to the universities as at present. All or most of the matching dollars from government would go to the three Councils in proportion to their base budgets and would be for their unrestricted use as decided by each Council. A percentage of the matching funds could go to the university receiving the private sector contribution, some of which would go to support the specific research activity envisaged in the original agreement; this would provide some incentive for increased private sector interest in funding university research. This alternative is by far the most desirable and feasible alternative.

2. Should the government require that each dollar to be matched go directly to the Councils, then the private sector grants, contracts and gifts are to be arranged with a university, as in 1. above; the funds would then be sent to a Council and redirected without peer review to the University with which the arrangement was made. All or most of the matching dollars would go to the Council

handling the cheque and would be used as determined by Council. The Councils would act simply as a conduit for private sector funds which would flow directly to the universities.

3. The private sector may of course contribute to the three Councils, provided that these funds and the matching dollars be used as decided by the Councils in support of their programs and under no circumstances to support earmarked research intended for the generation of proprietary information for the donor.

SUMMARY:

1. A program whereby the Government would match funds allotted by the private sector to the federal research councils is fraught with danger both to the universities and to the granting Councils themselves.

2. CAURA would prefer that the Government abandon such a program and accept its responsibility to assure adequate funding of its research councils and to encourage Canadian business and industry to increase their investment in research related to their own commercial needs and the demands of the marketplace.

3. Should the Government proceed with its proposal to match private sector grants, the most acceptable model would be for all private sector research grants, contracts and gifts, in cash or in kind, to go directly to the universities, as at present; matching dollars would go

mainly to the three Councils in proportion to their base budgets but part could go as an incentive to the university to be used mainly to support the research described in the private sector-university agreement.

4. If for accounting purposes the Government were to insist that private sector contributions go directly to the Councils, then these should be negotiated with the universities as at present, sent to one or the other council and redirected without peer review to the university in question. Most of the matching dollars would go to the Council designated to serve as a conduit for the funds and would be used to support its programs as it may decide.

5. The private sector may of course contribute funds to the Councils for use in support of their established programs, such funds to be matched by the Government. We would object strenuously were such gifts to be used to generate proprietary information for the contributor.

6. We would also object strongly to any attempt to change the character of the granting councils or to redirect their primary responsibility away from what it must remain: the support of excellence in basic university research in science, engineering and scholarship.

Prepared for CAURA by Dr. J.G. Kaplan, Executive Member CAURA, Vice-President (Research), University of Alberta.

JGK/gf
May 21, 1986.

CANADIAN ASSOCIATION OF UNIVERSITY TEACHERS

caut acpu

canadian association of university teachers

association canadienne des professeurs d'université

May 30, 1986

EXECUTIVE SUMMARY FOR CAUT
R&D DOCUMENT

There is widespread recognition that Canada must increase its research and development investment, that universities will have to play a major role in this expansion, and that the postsecondary education sector has suffered from a decade or more of underfunding. Nevertheless, the real problems of research and higher education are still not being addressed fully by governments.

Forums such as this one are welcome but will only be successful if rhetoric is downplayed and federal-provincial infighting is eliminated so that the real issues can be fully discussed.

CAUT believes that both levels of government have been pursuing, and continue to pursue, the wrong policies in relation to research and higher education. There is no clear national policy in either area. This has resulted in a tendency to reduce deficits using cutbacks in these areas. The federal transfers for postsecondary education under EPF have been cut a number of times. The provinces have underfunded the university system since the early 1970's. The federal granting councils have not been given the funds necessary to carry out their missions as outlined in their respective five year plans.

There have been many warnings about the problems besetting research and higher education. These include Dr. A.W. Johnson's report to the Secretary of State, the Wright Report, and the Report of the Study Team on Education for the Nielsen Report.

These reports, and other studies, have shown the strong link between the funding of universities and their research capabilities. They have stressed the importance of long-range planning and funding for the federal granting councils and the problems which arise because the Councils do not pay the full costs of research, including the indirect support costs.

While Canada is underfunding its higher education system, other countries are vastly increasing support for research and postsecondary education. In the United States, for example, thirty-six states increased funding to universities at rates higher than any Canadian province between 1983 and 1985. Twenty states, with a combined population of 99 million, increased funding at rates at least 50% higher than any Canadian province during that period.

Given the importance of the federal granting councils in the support of university research, the research community was most unhappy with the freezing of council funding for the next four years. This was particularly so when it had been disguised as a $300 million increase to the councils by an accounting trick. CAUT estimates that with even a modest rate of inflation, the councils will have 15% to 20% less funding in real terms at the end of this period.

It must be stressed that it is not only natural science and medical research that is at issue. The proposed five year plan of SSHRC clearly indicates the range of practical and applied research funded by that Council. These include the study of foreign countries, economic trade and development, labour relations, law, and business management, all of which are important areas of research for a trading nation like Canada.

Even under the most optimistic scenario, the three federal granting councils will receive only minimal funding increases in real terms. Much of this money will be "soft money" with no guarantee that it will continue from year to year. More realistically, the granting councils' budgets will decrease in real terms over the next four years. In either case, the councils will receive hundreds of millions of dollars less than is required to carry out their respective five-year plans.

RECOMMENDATIONS

CAUT urges that:

1. The federal granting councils be funded at the levels outlined in their respective five year plans.

2. The private sector matching grant scheme be limited to 2% of the base budget (one third the current federal proposal). This scheme should operate for three years. At the end of this period, it should be reviewed with an opportunity for public input.

3. The definition of private sector funds be widened to include private non-profit funding. In particular, this would allow for matching funds for non-profit sector funding of the Medical Research Council.

4. Revenue Canada should establish a method of prompt advanced rulings on the status of contributions to ensure that private sector donors receive full credit for their donations under the Income Tax Act.

5. Donations in "kind" should be treated as cash donations.

6. The matching grant programme should be regulated by a minimum of bureaucratic procedure. It should not be necessary for all matching grant donations to be channelled through the granting councils exclusively. It should be possible to arrange that donations could be made directly to universities, with the councils acting as reporting agencies.

7. The universities should be adequately funded to allow them to perform both their teaching and research functions at a level comparable to our major trading competitors.

8. Research grants should pay the full costs of research, including the indirect costs to the universities.

9. The federal government should not proceed with Bill C-96 which would cut the entitlements under EPF.

10. There should be a first ministers' meeting on postsecondary education and research at the earliest possible date.

CANADIAN CHAMBER OF COMMERCE

THE CANADIAN CHAMBER OF COMMERCE
200 ELGIN STREET • SUITE 301 • OTTAWA, ONTARIO K2P 2J7 • (613) 238-4000 • TELEX: 053-3051

OFFICE OF THE PRESIDENT

March 24, 1986

Hon. Frank Oberle, P.C.,M.P.
Minister of State for
Science and Technology
C.D. Howe Building
235 Queen Street
8th Floor - West Tower
Ottawa, Ontario
K1A 1A1

Dear Mr. Oberle,

Thank you for the time which you spent meeting with the Chamber's Research and Development Committee on March 13th. We are pleased to hear that more initiatives are planned regarding implementation of reforms suggested in the Wright Report regarding government intramural research. The preparation of a science policy paper by the Government is also welcomed by the Chamber, and we hope to meet with you again when this document is issued.

Now that the Government is actively seeking industrial support for university research, we have written to the Social Sciences and Humanities Research Council to attempt to establish a closer liaison (copy attached). Our Research and Development Committee members are already quite familiar with the Natural Sciences and Engineering Research Council and, in the months ahead, we will be discussing with them how we may work better together. We have also met with the Association of Universities and Colleges of Canada to establish closer linkages, and we will keep you informed of our progress in these meetings.

Concerning the trade deficit in high technology goods, we too share your deep concern. The solutions are not obvious, and a meaningful analysis to develop a strategy to address this problem would require a substantial effort, perhaps a government-industry task force. We would be pleased to recommend members of the Chamber to work with the government should you wish to explore this major economic problem in the near future.

Once again, thank you for meeting with our Research and Development Committee. We look forward to further meetings with your Ministry in the near future.

Sincerely,

Roger B. Hamel

RBH/haw
attachment

THE CANADIAN CHAMBER OF COMMERCE
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OFFICE OF THE PRESIDENT

August 13, 1985

The Hon. Thomas Siddon, P.C., M.P.
Minister of State for
Science and Technology
Room 119, East Block
House of Commons
Ottawa, Ontario K1A 0A6

Dear Minister,

Further to our May 13 meeting, the Chamber's Research and Development Committee welcomes this opportunity to comment on university research, funded through the Natural Sciences Engineering and Research Council.

In order to compete and prosper in a highly technological and competitive world, Canada needs a superior innovative capacity and a continuing adequate supply of manpower with excellent capability. This can only be achieved by assuring the quality and research capability of our university system. This is critical to fulfilling the manpower and research and development expectations of government, industry and society as a whole. Action to foster, develop and enhance the capabilities of our universities is essential so as to ensure the country's and our children's future.

Within the business community, there is growing concern that the financial squeeze on university funding may interfere with the ability of universities to respond to the demands of our society. Universities lack the funds to replace aging faculty as well as equipment -- a replacement that is a prerequisite to the education of students and scientists in the next 5 to 15 years.

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Increasingly, universities are finding it difficult, at times impossible, to meet the demands made on them for research and development because of space limitations, obsolete facilities and shortage of faculty and support staff. Enrollments are higher, and in real terms, funding per student has dropped by 20 percent or more in the last decade in many jurisdictions.

The Chamber recognizes the severe budgetary constraints facing the government and fully supports efforts to reduce spending in order to improve our country's deficit and debt position. Nevertheless, we believe that within the limits imposed by the existing budgetary constraints, university funding should be recognized as a priority area. In particular, we recommend:

- That these problems be addressed in federal/provincial negotiations on funding of post-secondary education, with due attention to the fact that universities must have adequate support for research programs if they are to meet governmental, industrial and societal needs for research and highly qualified manpower.

- That the private sector, labour and universities be involved on an on-going basis in negotiations on university funding and on technological and scientific goals of the nation. Planning should be on a long-term basis and abrupt changes should be avoided.

- That the need for quality in education and research be fully respected in the negotiations, even in the face of current financial constraints facing governments.

- That, in order to maintain the supply of scientists and engineers needed to fulfill research and development targets, graduate and postgraduate training at the universities be strengthened by the provision of appropriate support for equipment and facilities.

- That special incentives be considered to attract the most gifted students to the highest level of their profession. Identification and support of leadership and management potential is especially important.

- That foreign students, especially those in graduate programs, not be discouraged, for instance by higher fees, from coming to Canada.

- That technology transfer programs between universities and industry be encouraged.

The private sector recognizes the need for financial constraints and sacrifices. However, we believe that the development of scientific research and development at the universities must be supported at a very high level. The apparent short-term savings that might accrue through continued underfinancing would be offset by the tragedy that would almost inevitably follow.

Sincerely,

Roger Hamel

cc: The Hon. Walter McLean, Secretary of State
The Hon. Sinclair Stevens, Minister of Regional Industrial Expansion
The Hon. Michael Wilson, Minister of Finance
Provincial Ministers of Education

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OFFICE OF THE PRESIDENT

August 13, 1985

The Hon. Thomas Siddon, P.C., M.P.
Minister of State for
Science and Technology
Room 119, East Block
House of Commons
Ottawa, Ontario K1A 0A6

Dear Minister,

Further to our May 13 meeting, the Chamber's Research and Development Committee is pleased to have this opportunity to comment on science procurement practices of the Department of Supply and Services.

The Committee's key recommendations are summarized as follows:

1. The Department of Supply and Services should maintain its existing responsibility for scientific procurement in order to ensure greater uniformity. However, regulations governing scientific procurement should be revised in recognition of the special nature of this form of procurement.

2. Internal procedures governing the issuance of contracts should be revised and streamlined in an effort to shorten the time it takes for the Department to issue a contract.

3. Technologies, patents, copyrights and/or product innovations developed by the private sector with assistance from the government should be owned by the performing industry -- and not by the government.

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4. To assist small businesses in bidding for and negotiating contracts, an independent ombudsperson's office should be established.

5. In order to alleviate the problem of meeting fixed deadlines for bids, the Department's regional offices should be empowered to date-stamp bids on behalf of the Ottawa office.

Our more detailed comments on the points raised above, as well as on other issues of concern to the Committee, are discussed below.

Role of DSS in Scientific Procurement

The existing procurement procedures of DSS have been creating difficulties for our members. The root cause of the problem is the fact that these procedures fail to recognize sufficiently the differing nature of R and D procurement -- as opposed to the procurement of standard goods and services.

We believe that measures should be taken to improve the existing system. We suggest that the Science and Professional Services Directorate of DSS be given the authority to exempt science contracts from terms and conditions which are not appropriate to scientific procurement. Efforts to develop special regulations for such procurement must continue. Moreover, the Director General of the Directorate must have the discretionary authority to interpret these regulations.

We strongly feel that DSS should maintain its responsibility for scientific procurement. This will ensure greater uniformity in the procurement system.

The establishment of a totally new procurement system, with responsibility resting in other departments, will create a host of anticipated and unanticipated problems. We note that a number of government departments and agencies are already responsible for their own procurement -- these include the National Research Council, the Canadian International Development Agency, Health and Welfare as well as Consumer and

Corporate Affairs. Based on the experience of our members, direct procurement by these bodies has not produced better results. In some instances it has taken longer to negotiate contracts than it has with DSS. Moreover, the DSS route has tended to offer greater access to potential bidders.

Another major concern is that each procuring department and agency follows its own procurement practices. This can be confusing for business and can create roadblocks to bidding. Therefore, we recommend that where procurement is done directly by government departments and agencies, the same procedures and practices as applied by DSS be adopted.

Scientific Procurement Procedures

A major concern to business is the length of time it takes for DSS to issue a contract. In our experience, the contracting departments tend to respond relatively quickly in reviewing the scientific content of a proposal. However, the DSS process of translating this into a written contract as a rule takes longer than is warranted -- particularly in view of the fact that much of the contract language is standardized.

We recommend that the various steps through which a contract passes internally within DSS be reviewed and streamlined. The goal should be to draft contracts in one or two weeks where standard language is used and where a statement of work approved by both the client department and the company is provided. Currently, it takes about 20 weeks to respond to such a standard situation, particularly for larger contracts. In some circumstances it can take a year to complete the process. We suggest that the Department consider: (a) applying strict time limits for processing contracts; and (b) establishing procedures to monitor the time it takes to process proposals to ensure compliance with established time frames.

Right to Intellectual Property

The government retains the right to intellectual property in research contracts in which DSS participates on a shared-cost basis with private sector companies. We note that such innovations normally build on a base of expertise established in industry, with government assistance only partially covering the real costs of development.

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We strongly believe that technologies, patents, copyrights, and/or product innovations developed by the private sector with assistance from the government -- under either grant or contract agreements -- should be owned by the performing industry.

This approach would promote the development of the technology which would benefit all Canadians.

"Make or Buy" Policy

The "make or buy" policy, which the Chamber has endorsed enthusiastically, was introduced about ten years ago. We note, with disappointment, that government departments have been slow to adopt this policy. One indication of this: The percentage of R and D activities carried out under contract has not increased in recent years.

We observe that public servants responsible for R and D program delivery are reluctant to contract out work. In part, this occurs because the procurement rules favour internal R and D activity. For instance, cost comparisions of in-house versus outside activity are generally unrealistic, with in-house cost estimates being low. Yet, these cost comparisons are used to justify performing the activity internally. In other instances, government scientists are unwilling to support external projects because of the administrative effort that would be required of them. Some scientists view such proposals as competing with their own research. Given these considerations, there is little incentive for government employees to promote contracting out of activity.

We recommend that the implementation of "make or buy" policy be reviewed and systems established that are supportive of contracting out to the private sector. One approach: A specific target ratio should be set for in-house versus contracted-out activities, and this ratio should be in line with that of other countries.

Unsolicited Proposals

The Chamber is generally very supportive of the unsolicited proposals program which arose out of the "make or buy" policies. However, we feel that the program could be improved so that it is even more supportive of private sector research and development activity.

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For a proposal to be accepted, a key requirement is that the technology being suggested should be of use to the sponsoring client department. However, in some instances, a proposal might be worthwhile to the private sector company even though the technology is not needed by government. Proposals which do not have a departmental sponsor should be considered for funding by the National Research Council.

Negotiation of Overhead Rates

DSS negotiations with industry on overhead rates are very time consuming. To simplify the procedure, business should be allowed to apply rates based on market forces, when competitive bidding is involved. In other situations, rates charged to the government should be in line with those a company normally charges its other clients for work of similar scope and nature.

Another concern is that the system tends to be arbitrary. This is because in some circumstances DSS can request an audit of costs with a view to changing the agreed-upon rates. We note that currently conflicting language is used in the government's "fixed-price" contracts. At the very least, the cost of such audits should be automatically considered to be a direct cost of the contract.

"Ombudsperson's Office"

It has been our observation that too often small firms experience difficulties when bidding and negotiating. The establishment of an independent "ombudsperson's" office to assist small business people would help alleviate this problem. An ombudsperson would be particularly helpful in instances where disputes arise between the private sector bidder and DSS. We emphasize that the staffing of such an office should be done through reallocating personnel from elsewhere in the Department -- and not by adding new staff.

Acceptance of Bids by Regional DSS Offices

Meeting fixed deadlines for bids under the current procedures represents another area of concern to business.

It is not unusual for bidders to receive proposals for bids only several days before the deadline. When this happens, there is very little time available to prepare a bid and to ensure that it is received on time by DSS. In our view, a number of measures could be implemented to facilitate the bid submissions process.

DSS has a network of regional offices across Canada. We recommend that these offices, in addition to date-stamping bids for contracts which they issue, provide the same service on behalf of the Ottawa office. The requirement that bids be submitted directly to Ottawa places regional bidders at a significant competitive disadvantage.

When couriers are used to deliver bids to Ottawa, they are not permitted access to the bid opening room in DSS. Because of this, several additional days are lost to the bidder as the bid makes its way from reception to the bid room. We recommend that a system be established to allow couriers direct access to the bid room.

Pre-Qualification Process

We compliment the Department for establishing and following the existing pre-qualification procedures. The pre-qualification process both simplifies and speeds up the bidding process. We encourage the Department to promote wider use of this process. In our view, wider use would encourage development of technological capability in the private sector.

Competition from Government-Supported Organizations and Universities

In our view, DSS should make every effort to emphasize its policy of not accepting bids from public sector organizations -- where private sector capability exists. We suggest that the policy be monitored periodically to ensure that it is being adhered to to the maximum extent possible.

We hope that the views expressed above will be of assistance to you. We would be pleased to elaborate further on the points raised with either you or your officials.

Sincerely,

Roger Hamel

cc: Hon. Harvie André, Minister
Department of Supply and Services

Hon. Robert de Côtret, President
The Treasury Board

THE CANADIAN CHAMBER OF COMMERCE
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OFFICE OF THE PRESIDENT

October 9, 1984

The Hon. Thomas Siddon, P.C., M.P.
Minister of State for Science
and Technology
Room 119, East Block
House of Commons
Ottawa, Ontario
K1A 0A6

Dear Mr. Minister,

The Research and Development Committee of the Canadian Chamber of Commerce has followed with great interest the work of the Task Force on Federal Policies and Programs for Technology Development. The Committee has made several presentations to the Task Force on behalf of the Chamber and is pleased to have this opportunity to comment on the recently released report of the Task Force.

The Report promotes greater involvement of the private sector in government R and D activities and greater reliance on market forces to shape Canada's R and D effort. We fully endorse this approach since we believe that greater reliance on the private sector and on market forces would produce a better utilization of financial and human resources devoted to R and D. Our comments on specific proposals are summarized below:

Greater Involvement of the Private Sector in Government R and D

The Report suggests that there should be more private sector involvement in R and D activities carried out in government laboratories. We believe that such private sector involvement would bridge the communications gap between the industrial and the government R and D communities. The result should be R and D activity that is more supportive of Canada's existing and future industrial activity. Particularly important from the efficiency and relevancy point of view is greater private sector input in the planning of new in-house R and D activities.

Private sector representatives should be appointed to the boards of directors of the various federal laboratories. In addition, the mandates of government laboratories need to be reviewed on a periodic basis by specially established peer groups. We strongly believe that in order to be effective, the appointees to both the boards of directors and the peer groups must possess appropriate expertise and should, therefore, be selected to serve on the basis of merit. Moreover, these appointments should be made only after consulting with business and/or professional associations as well as labour. The Chamber would welcome the opportunity to suggest names of people from the private sector research community.

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Contracting Out of In-house R and D

The Report recommends that in-house R and D should be restricted to cases "where there is a need for secrecy or neutrality, or when contracting out is not cost-effective in the long run". We welcome this approach and believe that much more contracting out of in-house R and D activities needs to take place.

One approach to contracting out of in-house R and D might be through the unsolicited proposal program administered by the Department of Supply and Services. The DSS program is a good example of how the private sector can be utilized to provide some direction to public R and D spending.

Review of Government Laboratories

We believe that there should be an independent and detailed review of the mandates of government laboratories. The reviewing body should be asked to recommend that where mandates of government laboratories are no longer suited to today's environment, they be either changed or the laboratory be wound down.

Greater Reliance on Market Forces in Shaping R and D Activity

The Chamber agrees with the Task Force's suggestion that the tax system should be used to support R and D because this approach would allow the marketplace to pick and choose suitable R and D projects. This should encourage the development of marketable products and processes.

Government Industry Support Programs

The Task Force's Report suggests that many of the existing industry support programs should be either discontinued or greatly modified. It has been our observation that many of these programs have indeed outlived their usefulness. Therefore, we fully support this recommendation.

We believe that it would be useful to undertake a cost/benefit analysis of these programs to ensure that they reflect today's needs. In this regard, we note the recent Income Tax Act changes which provide a new opportunity for companies, including the smaller companies, to raise financing for R and D activity. As a general rule, we believe that this approach is preferable since it is based on market forces rather than on bureaucratic decision-making.

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Government Procurement of Technology Intensive Products

We concur with the Report's observation that there is a general lack of interest shown by government departments in the purchase of newly-developed Canadian products. The purchase of high technology products from Canadian suppliers should be encouraged whenever costs are competitive. We believe that this should be particularly applicable to departments and/or government agencies with a strong technological expertise (and in situations where the amount of money at risk is reasonable).

Support of University R and D

We welcome the idea proposed by the Task Force to extend tax credits for R and D to universities where the R and D is supportive of industry. This approach might lead to a better exchange of information between universities and industry. At present, the links between the two sectors are relatively weak. There is only one formal mechanism for the transfer of technology between universities and industry, and that is the National Research Council's PILP program. Even here, however, problems exist since the system can be cumbersome and is too often administered by people with insufficient market experience and knowledge.

We also support the Report's recommendation that more funding for R and D be directed to universities. We believe that universities will play an increasingly important role in research and development, and this fact should be recognized in government funding of R and D activity. The goal should be to direct a greater overall share of R and D spending to universities. Therefore, any increases in federal spending must not be accompanied by cuts of similar amounts by the provinces.

We note that some of the funding should be directed to establishing and promoting "Centres of Excellence" in order to focus R and D activity and avoid costly duplication.

Definition of R and D

We support the suggestion made by the Task Force to extend the definition of R and D for income tax purposes to make it more compatible with that used in the United States, thereby effectively eliminating the "wholly attributable" rule used in Canada. It must be recognized that most small companies cannot afford to employ full-time staff in R and D. Therefore, often R and D is performed by staff on a part-time basis using existing facilities. These realities should be allowed for in our tax system.

... 4

Transfer of IRDP to the National Research Council

Traditionally the National Research Council has been involved in basic research. We believe that this is an appropriate role for the Council and question the advisability of the Task Force's recommendation to transfer the technology-development portions of the IRDP from DRIE to the Council. Unlike DRIE, the Council has limited experience with industrial research. Therefore, we feel that the status quo should be maintained in this area.

Role of the Chief Science Advisor

We believe that this position is an important one and should continue to exist. To be effective, we suggest that the Science Advisor strive to obtain maximum input from the broader academic and industrial scientific communities, in addition to obtaining the views of the various government departments. The Science Advisor should be accessible to people outside of government.

We would be pleased to explore further the ideas expressed in this letter with either you and/or your officials. A small delegation of the Chamber's Research and Development Committee would be pleased to meet with you in Ottawa, at your convenience.

Sincerely,

S. F. Hughes

:RD

CANADIAN CHEMICAL PRODUCERS ASSOCIATION

TOWARD A NATIONAL SCIENCE AND TECHNOLOGY POLICY FOR CANADA

Introduction

The Canadian Chemical Producers' Association welcomes the opportunity to participate in discussions leading to the development of a national science and technology policy for Canada. The intention in this paper is to highlight a number of key concepts which it is believed are fundamental, and we expect to elaborate in greater depth and detail as the policy development activity evolves over coming months.

The Association represents some 70 manufacturing companies which produce about 90% of Canada's total output of manufactured chemicals. With annual production in the order of $8.5 billion, the industry directly employs more than 28,000 people, of whom approximately 18% are university graduates and a further 13% technicians. Thus the industry is a technology intensive one with a strong involvement in industrial research and development. It purchases from a very broad range of resource industries, equipment suppliers and others, and virtually all of its output flows into other manufacturing processes at home or abroad before reaching final consumers. Thus the industry is extremely sensitive to its own international competitive position and those of the industries it serves.

Policy Objective

The CCPA believes that the primary purpose of a national science & technology policy should be to improve the competitive strength of Canadian businesses. Specifically, such a policy should aim to ensure that Canadian enterprises have available to them, and are free to use, the most up-to-date technology extant. **In other words, the policy has to focus on providing support to companies to acquire, develop and use technology as an integral part of their business strategy.**

Acquiring Technology - Make or Buy

Canadian companies will be able to develop only a part of the technology essential to the achievement of competitive goals. **Canadian science & technology policy, therefore, must address a mix of buy and make goals.** (Also, as our technology development activity grows, we will have to recognize sale of technology to other countries as a small but important part of science & technology policy.)

Almost all technology evolves with time; technology that is not evolving is becoming obsolescent. If enterprises are to be dynamic and competitive the real choices are:

1) to develop (make) one's own technology and build on it to provide for the necessary improvements to maintain competitiveness;

2) to buy technology and develop an in-house capability to provide for the necessary improvement to maintain or even gain in competitiveness (a policy followed well in Japan);

3) to buy technology and then buy improvements as required.

Technology is seldom uniquely developed and a mixture of (1) and (2) is common and often desirable.

Purchased technology will always be very important to Canadian businesses. **National science & technology policy therefore must place no artificial impediments on its acquisition, use, and dissemination.**

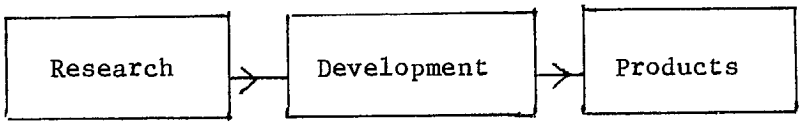
Nevertheless, Canadian science & technology policy obviously cannot rely on the purchase option alone. Technology available for purchase is more likely to be for maturing products and processes. Canadian businesses will need to develop their own technologies and to build on purchased technologies. Both of these are considered to be encompassed in the "make" option.

Science and Technology Models

A useful approach to the development of science and technology policies is the examination of research and development models.

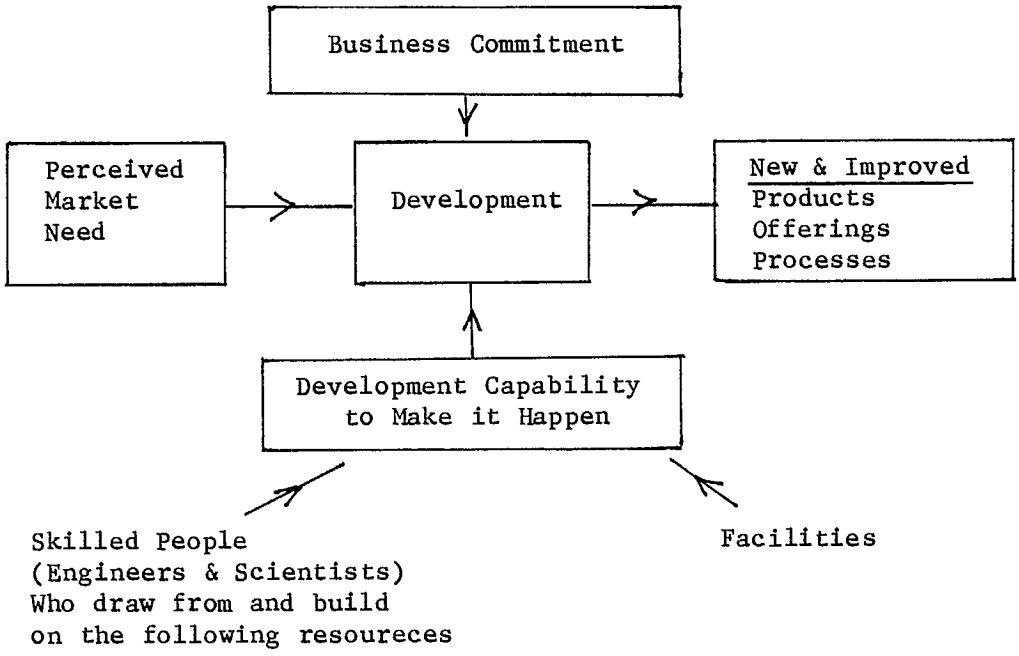
a) A Common Contemporary Model

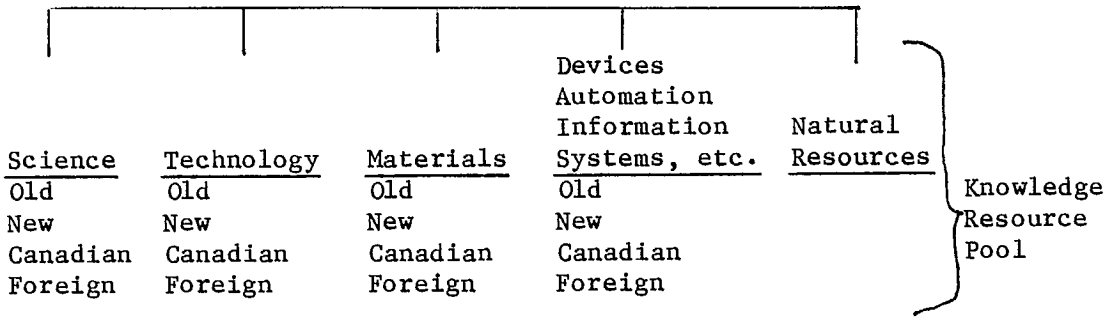
A common model used to relate research and development presents a research push picture.



It is now generally accepted that it is much more useful to consider technology with a market focus in mind.

b) The Market Focussed Model





Elements of Technology Development

The market focussed model, while perhaps overly simplistic, clearly shows the main components of the successful development of new and improved technology, viz:

Perceived Market Need
Business Commitment
Skilled Development People
Development Facilities
Knowledge Resource Pool

An effective science & technology policy needs to address ways of enhancing each of these five basic parameters.

1) Perceived Market Need

Both the specific need and its potential market size are important. Canadian government policy should consistently be directed to opening up additional market opportunities to technology-based goods manufactured in Canada. Tariff and non-tariff trade barriers are key issues and Canadian business needs to look at foreign markets with even greater attention, especially in evaluating the opportunities arising from development activities.

Government procurement policies can have a very positive influence on market opportunities.

Businesses (including entrepreneurs) are the best vehicle for identifying perceived market needs and for making the commitment to follow through. **Industrial technology development should be done in industry, and not in government laboratories with the idea of transferring it to industry.**

2) Business Commitment

Expenditure on Research and Development is inherently "risky" because of the uncertainty of success. Business and enterpreneurs will only make the commitment to acquiring or developing technology if they have a reasonable probability of earning a satisfactory return. **Therefore, a stable and healthy economic climate is the single most important factor in influencing investment in technology.**

It is also essential that government actions provide a positive environment for undertaking a business commitment. **Canada must have competitive policies on energy, intellectual property rights, taxation and general regulation of companies.**

Canada has a mix of tax incentives and grants which encourage or assist R&D activities in businesses. **A key issue is that the nature and level of support be comparable to those provided in competing countries.** The "risk" of development for companies is related to both the cost of R&D and the time before significant sales revenue will occur. This is a particular problem with major developments in some of the new technology areas, such as biotechnology, ceramics, and advanced composites. The "risk overhang" can be of literally "bet the company" proportions. In many countries fully funded developments in advanced technologies for military purposes have direct commercial spin-offs of great value. Canada's science & technology policy should recognize the different priority accorded defense in this country and provide equivalent risk sharing to be able to compete in the spin-off areas (e.g. advanced materials).

Our business, science and engineering schools need to ensure that an understanding of the value and importance of technology development is introduced into the undegraduate curricula.

3) Skilled Development People

Skilled development people will be key to a successful Canadian science & technology policy. We must ensure an adequate supply of well trained people. NSERC has addressed the potential shortage and its importance in its planning documents.

University research plays an essential role in providing the basis and environment for educating the people who will fit into the industrial development activity, and who will carry with them into this activity, not only a sound understanding of scientific investigation, but also a sound ability in acquiring and building on existing knowledge. The equally important role of educating the next generation of "teachers" must be recognized.

It will be necessary to increase funding to support university research and research facilities. We encourage the development of relatively few centres of excellence so that the available funds can be most effectively used.

The Ph.D. program has tended to become longer in Canadian universities. A shortened Ph.D. program (returning to the 3 year goal from bachelors degree) is recommended because of the potential to increase the number of people receiving this training at any one time, and to make it more attractive for our best young graduates to pursue.

4) Development Facilities

Development facilities should normally be located in the corporation undertaking the work. They need to be of high quality and take advantage of the latest technology.

There are some situations where shared facilities offer a definite advantage:

- unique national facilities (e.g. wind tunnel);
- contract development facilities which offer both facilities and people skills and are of particular value to smaller companies (e.g. ORF);
- university/industry shared facilities (e.g. specialized analytical equipment).

Modern developments lead quickly to the need to supply commercial product. It is frequently appropriate to make initial commercial product offerings from pilot facilities. **Science & technology policy should ensure that this type of development is encouraged and the R&D incentives related to facilities are not inappropriately penalized.**

5) The Knowledge Resource Pool

As already noted, most of the knowledge resource pool will be international and Canada will only be a minor contributor to the pool. Canadians will want to be able to have access to all of it, and the most important consideration is that our development people have this ability. **Our science & technology policies must encourage the broadest access and utilization in pursuing Canadian developments.** We encourage ongoing improvements in knowledge access systems.

Canadian science activity will always be small relative to the world total. In this situation, we should focus our relatively limited efforts on the support of Canadian industrial competitiveness. In addition to the educational aspect, the other role of university research is to develop new scientific understanding based on well-conducted investigations. **Improved university/industry relationships should be encouraged as the best way of making university research more relevant to industry.** The appropriate role for university research is probing scientific investigation; industrial research should carry out the development and commercialization. We are concerned that too great a focus on "making universities relevant" might lead to short term development activities to the detriment of both research and education.

The knowledge resource pool goes well beyond new discoveries in science. In fact, the "new science" element of new industrial developments can vary from being of crucial importance to being virtually insignificant. Technology developments such as the computer and new materials can have profound implications in developing improved processes and products. **Our science and technology policy needs to recognize the breadth and importance of the total knowledge resource pool.**

Related Issues

1) Government R&D

Government R&D may be appropriate in certain fragmented industries such as agriculture, but it is not an appropriate strategy for industry generally. The CCPA supports the Canadian Manufacturers' Association (CMA) recommendation that in developing a national science & technology policy, federal and provincial governments should establish the principle that government should not generally do industrial technology development for the purpose of transferring it to industry.

2) Technology Centres

The Canadian Chemical Producers' Association supports fully the recommendations on technology centres made by the Canadian Manufacturers' Association in its paper "Improving our Industrial Competitiveness". In particular proposals for new centres should be initiated by the private sector clients they will serve. This would ensure that centres are established on the basis of identified industry needs, not on unilateral government views of what those needs are. The result would be more effective technology centres at lower cost to government.

CANADIAN COUNCIL OF PROFESSIONAL ENGINEERS

EXECUTIVE SUMMARY

In order to maintain our high living standards and material prosperity, the Canadian Council of Professional Engineers (CCPE) believes that Canada needs a National Policy on Science and Technology. International competition, global market changes and widespread technological innovations are exerting an undeniable influence on the way every industrialized country organizes its economy. For Canadians, the way ahead will be described by the success we enjoy at managing our inherited wealth, and at creating new wealth. There is an overall pressing need to refine and make better use of what currently exists. Only through a new Science and Technology Policy for Canada, can Canada's wealth and competitiveness be maintained.

In Canada, government policies have been somewhat successful in engendering technology development in industry, universities and government. Unfortunately there is seldom any common thread or direction inherent in the current system. In this context, we welcome the federal government's initiative in setting up a forum to discuss a National Policy for Science and Technology in Canada. The commitments enunciated by the government, i.e. to be more fiscally responsible, to redefine government's role in the economy, to adopt policies fostering investment and innovation, and to implement these changes in an open, compassionate and consistent way, are laudable objectives to which we give our unqualified support.

By the same measure we agree that there is room for improvement and that a new Science and Technology Policy for Canada is imperative. Specifically we would like to see:

MARKET-DRIVEN RESEARCH AND DEVELOPMENT

In Canada research has frequently been undertaken for the sake of research and not to meet the requirements or potential requirements of industry. The CCPE recommends that university and government research become market-driven in order to facilitate effective industrial R&D to support a new science and technology policy in Canada. R&D contacts between government, business and industry must be enhanced to ensure the application of Canadian scientific knowledge to our industrial needs.

TAX INCENTIVES

It is generally accepted that tax incentives are the most effective means to support companies which invest in technology. A recent survey concluded that 86% of companies would have had their R&D programs adversely affected had it not been for federal tax incentives. Tax incentives must be improved by the federal government through extending 100 per cent refundability for unused R&D incentives to all companies. In addition provincial governments must stop taxing federal R&D tax incentives.

DIFFUSION OF TECHNOLOGY

A national science and technology policy requires that an appropriate and effective system for the diffusion of technology be realized as soon as possible. There must be greater collaboration in all sectors of government, academia and industry to ensure that research and development becomes market-driven.

Furthermore, long term planning must become a reality, policy changes must be phased in to minimize disruption in industrial planning, and government agencies involved in R&D must be de-politicized.

UNIVERSITY RESEARCH

Canadian universities, specifically engineering schools and faculties, have suffered significantly over the last ten years due to reduced funds being made available for research equipment and operating grants. Student/professor ratios have grown alarmingly to the point that quality education is threatened. If Canadian researchers cannot undertake research or study effectively, then it is impossible to develop an appropriate national science and technology program. Increased government funding is required immediately to upgrade university research.

GOVERNMENT RESEARCH

Canada is far from receiving maximum benefits from money spent on government laboratories. Government laboratories continue to remain research oriented. Research must be linked with development in order that results can be directed at markets thereby yielding a sensible return on investment. CCPE recommends that government laboratories should be generally restricted to doing R&D to fill government needs. All other government funded research should be contracted out to the private sector.

CANADIAN COUNCIL OF TECHNICIANS AND TECHNOLOGISTS

EXECUTIVE SUMMARY

The Canadian Council of Technicians and Technologists (CCTT) is a federation of ten provincial professional associations, societies and corporations, representing the interests of more than 34,000 Engineering and Applied Science Technicians and Technologists in Canada.

The CCTT maintains that in order to reinforce Canada's position in World Markets, the country's technical community - Industry, Federal and Provincial research agencies and Universities, Colleges of Applied Arts and Technology and Technical Institutes must work toward a common goal.

In the short term, industry must apply available and developing technologies in order to improve the overall efficiency of the Canadian economy.

In the long term, there is an urgent need to continue and improve the development of our highly skilled human resources. Their expertise forms the foundations of our scientific and technological communities.

The following is a summary of the CCTT's recommendations for consideration in the formulation of a National Science and Technology policy.

The CCTT believes that:

1. Access to direct funding for Applied Science Research efforts by Canada's Community Colleges and Technical Institutes would broaden the base of Research and Development (R & D) in Canada and increase the number of innovative products and services of Canadian Origin. (p.4)

2. In order to optimize educational resources and inherent skills in individuals, and to meet present and future Applied Science manpower requirements in industry, the concept of two streams of technical education - Applied and Theoretical - should be endorsed, and further that post graduate programs in Engineering and Applied Science Technology be expanded and supported in Community Colleges and Polytechnical Institutes.(p.5)

3. Strategically placed Polytechnical schools, or satellite programs should be created to provide post graduate training in technology. (p.5)

4. A mandatory system of Program Accreditation be implemented for Engineering and Technology programs in order to stimulate curriculum improvement and the development of innovative new technology programs. (p.6)

5. A Federal-Provincial support program should be designed for Science and Technology Career Counselling in order to provide informed guidance to our future workforce.(p.7)

6. The principle of every person's "Right to Training" should be implemented. (p.8)

7. The concept of the "Applied Science Team" should be entrenched in any policy developments for Science and Technology.(p.11)

8. All provincial governments be urged to review existing engineering legislation with the resolution to remove restrictions preventing industry from obtaining the most efficient use of Applied Science personnel. (p.9&12)

CANADIAN FEDERATION OF BIOLOGICAL SOCIETIES

The Canadian Federation of Biological Societies (CFBS) welcomes the joint initiative of federal, provincial and territorial ministers of science and technology to hold a "Canadian Forum on a National Science and Technology Policy". We are grateful to be offered the opportunity to take part in such a timely event for the future of our Country.

CFBS is a federation of nine learned societies and represents near 4 000 biological and medical researchers working in the private sector, government laboratories and universities across Canada. The majority of our members are constituents of the Medical Research Council (MRC) and the Natural Sciences and Engineering Research Council (NSERC). Member societies of CFBS are:

- Canadian Physiological Society
- Pharmacological Society of Canada
- Canadian Association of Anatomists
- Canadian Biochemical Society
- Canadian Society for Nutritional Sciences
- Canadian Society for Cell Biology
- Canadian Society for Immunology
- Society of Toxicology of Canada
- Biophysical Society of Canada

Question 1 a: Is Canada getting maximum benefits from money spent on university research? If not, what steps should be taken to improve the situation?

No, because of the underfunding of universities by the provinces. Research grants must now cover far more expenses than they used to. Faculty members have less time to spend on research because of increased teaching requirements (more students, fewer faculty).

The federal government must find some way of getting money into the universities at least to support the indirect costs of research, and must demand a certain percentage of faculty time for research, if they are to receive grant support. All basic research is now to be carried out in university laboratories, given the emphasis in government laboratories on industrial support and technology transfer (eg. NRC). Therefore, it is more important than ever that the federal government support our universities. Since basic research is, and should be, a federal priority, we cannot afford, as a nation, to leave that responsibility to the provinces.

RECOMMENDATION 1:

In order to prevent further degradation in the universities ability to support the basic research (that is essential to generate applicable knowledge), the federal government should not proceed with its proposed modification to the EPF (Bill C-96). Rather, there should be a First Ministers' meeting called to discuss solely the state of higher education in Canada.

This conference would discuss and hopefully implement the proposals put forward during the forum to improve the state of the universities, including their ability to support research and development.

Question 1b: If new money were to become available, should it be used for university research and, if so, how should it be spent to assure maximum benefit to the Country?

All new money which is to become available for basic research (our life blood in coming years, without it there will be no technology to transfer obviously) must go to the universities since neither government nor industry is involved in basic research according to MOSST's background document. Money for basic research, by the very nature of science, cannot be directed.

RECOMMENDATION 2 (i) and (ii):

In order to ensure that research infrastructure in Canada can plan its research efforts and achieve them in the most productive way, we recommend that:

(i) the federal government be urged to endorse the objectives of the Five-Year Plans of the granting agencies as submitted in the Fall 1985 and,

(ii) the new base budget of the granting councils be indexed for inflation, using the present fiscal year;

This modification to the proposed budget over the next five years is a modest proposal that we consider minimal, though essential, to maintain the high quality of research presently done in Canada and to optimize the chances of successs of the new Matching Programme.

Question 1 c: How can we encourage better linkage between the private sector and universities?

(i) The universities are now reaching out to industry with more than an open hand (looking for donations as in the past). There is a role for the type of research park many universities are developing. Industry is not likely to support truely basic research because of the lack of guaranteed short-term gain. The federal government might be able the help (eg. financially) in developing research parks.

(ii) In a trial to define the parameters of a Matching Programme acceptable to the granting councils, the institutions and the private sector, CFBS would like to recommend the following scheme to the Forum:

RECOMMENDATION 3:

In order to optimize the efficiency of the Matching Programme (i.e. attract new money from private sector quickly, maximize the fraction of the matched money being given to the granting councils and minimize the operating costs), the Government should build on existing arrangement among the institutions, the granting councils and the private sector, in the following way:

1. The private investor that does qualify for the Matching Programme should receive an attractive incentive in terms of tax credits, after he paid the full costs of the research contract, as it is the case now, to the university.

2. The institution or the investigaor who did recruit the private investor's contract or donation would submit an application for the Matching Programme to the pertinent council,

and accordingly receive 15% of the matching fund attached to this specific research contract or donation. In the case of a research contract, this would be a net incentive of 15%, since there are provisions covering overhead cost in the actual research contract. We believe that such a figure (15%) is sufficient to act as an incentive to the investigator-university system, and small enough to prevent the private investor to "level down" or invest less for the same pay-off.

3. After ensuring that the eligilibity criteria are met by applicants, the Granting Councils would submit the application to the Government. The matching funds would then flow, to be partitioned two ways: at least 85% would go directly to the relevant granting council to support its base programs; the remaining portion (up to 15%) would go directly to the recruiting individual or the institution for the support of eligible research in any area of endeavour.

4. As far as the eligibility criteria are concerned:

a) Donations from private sector as well as research contracts should be eligible to the Matching Programme;

b) The eligible research should be defined to include all activites considered as research and scholarship by universities and the granting council. We would like to suggest the following definition which encompasses both basic and applied research as well as development:

> "Research and development is exploratory and innovative work undertaken on a systematic basis towards the acquisition of new knowledge in new ways. New knowledge involves the integration of newly acquired information into existing hypothesis, the formulation and testing of new hypothesis or the re-evaluation of existing observations."

(iii) Improving communication between university and corporate researchers is an important step in facilitating collaborative projects. A means of promoting interchange as well as providing a mechanism for directly facilitating cooperative research would be the co-sponsorships of post-doctoral fellows by a university and a corporation. Such arrangements could also enhance the subsequent employment prospects of such fellows.

(iv) Finally, we believe that increased corporate R & D will only come out of increased corporate R & D spending in general (i.e. it will not supplant current in-house corporate R & D) regardless of what happens in government R & D. Unfortunately, there are major barriers to this increased R & D in general.

These barriers are a function of the nature of the Canadian political and economic system which is resource and branch-plant oriented in many aspects. In our own field, we cannot see any increase in innovative pharmaceutical R & D (or related emerging biotechnology) occurring until there is patent protection of intellectual property (as it applies to medicines and foods) to something approaching the levels provided in other developed countries.

Moreover, on a short and mid-term basis, we believe that pharmaceutical industry is the only realistic source of private sector contribution that will allow the Medical Research Council to reach the matching fund levels ($111 million) it desperately needs to maintain its 1985-86 purchasing power over the next five years, along with the Federal Five-Year Funding Plan recently adopted. Patent Act is the cornerstone of pharmaceutical research done in Canada:

RECOMMENDATION 4:

In order to ensure that (i) Canadians obtain the benefits of increased indigenous research and industrial development, and that (ii) drug prices do not rise beyond average world level, it is recommended that Federal Governement be urged to table concrete measures that will link the extended patent protection to the amount spent by the pharmaceutical companies on research done in Canada and to drug prices.

Question 3: How could Canada realize more benefits from international science and technology developments?

Canada will realize benefits in proportion to its contributions to international science. If basic scientists have something to say they get invited to international meetings. CFBS holds an Annual Scientific Conference, the only one of its kind in Canada, which encompasses all areas of biological research. Over the past decade, scientists of international renown have been deliberately invited to participate in our meetings.

Question 4: Should Canada target its science and technology resources in a range of strategic areas so as to maximize return?

No. This is very dangerous for basic research. If some areas are to be completely cut off, it is probably also not a good idea for applied research. Who decides how to target(or what)?

Question 9: What can be done to promote greater public awareness of, and participation in, the issues of science and technology?

We agree that more emphasis must be put on "public awareness of science". Over the past four years, CFBS organized Public Awareness Sessions during its annual meeting. This year in Guelph, two sessions have been organized: one on "The need for Animal Use in Research", and a second one on the "Ethics and Morality of Biotechnology- the Rights and Wrongs". Moreover, CFBS in collaboration with the Canadians for Health Research (CHR) obtained a grant from the "Public Awareness Program for Science and Technology" that is administered by the Department of Supply and Services. Funds have been received in 1985 to collect the information necessary to produce an inexpensive non-technical paperback for the general public which will: describe how individual research studies contributed to recent clinical advances in the diagnosis and treatment of five neurological disorders; document the significant role of Canadian scientist have played in these advances; and, profile a few of the Canadian scientists whose research contributed in a major way to these advances. The publication of the paperback is now pending upon the acceptance of our 1986 application, that has been jeopardized by the $400 000 cutbacks to the program done this year.

Question 12: What are the respective roles of the federal government, universities, private sector and our organization in the development and implementation of a National Science and Technology Policy?

Major role is for federal government: both development and financial implementation. The role of an organization like ours is the actual implementation in the laboratory. The universities are crucial to maintain the research foundation and to produce highly qualified personel to carry out the policy. Canadian business must become more entrepreneurial; if they do not gain ground, they will lose it.

CANADIAN FEDERATION OF INDEPENDENT BUSINESS

EXECUTIVE SUMMARY

INNOVATION, TECHNOLOGY TRANSFER AND SMALL BUSINESS DEVELOPMENT

Paper prepared by the Canadian Federation of Independent Business for the National Forum on National Science and Technology Policy, Winnipeg, June 1986.

Introduction

Most general discussion on the development of small business in Canada usually centres on the broad issues of small business policy -- i.e. financing, management, taxation, and regulation. A comprehensive approach to the development of small business requires that significant attention must also be paid to the issues of new technology development and transfer to the small business sector.

The competitive advantages of using new technologies have not gone unnoticed by independent business men and women all across our country. In a comparative, 11 national survey conducted by the C.F.I.B. in conjunctions with the International Small Business Congress, it was the Canadian business community that ranked higher than all other developed nations in regard to the degree in which they were searching for information on technological changes that could be used in their business.

In addition to being important users of new technology, small business in Canada also has a major role in the research, development and production of new technology. Based on a survey of American R. & D. companies, small firms take 27% less time to complete the R. & D. cycle - from initial research and design to bringing the product to market. Small R. & D. companies also have 2.5 times as many innovations per employee as large R. & D. firms.

The purpose of this paper is to examine both of these aspects of technology transfer -- direct innovation by small business in development and transfer of new technology to the market place, as well as the adoption and transfer of these new technologies to improve productivity throughout all sectors of the small business community.

Part I - Technology Transfer and Small Business Productivity

Independent small business faces numerous obstacles in acquiring modern technology. This is principally due to the struggle to retain sufficient earnings for investment in new technology, and because their very independence often prevents proper access to information on new technological problems, or to even recognize the existence of a potential problem due to antiquated technical processes and equipment.

In order to overcome these barriers, several strategies are proposed to help the small and medium sized business sector recognize, acquire and adopt new technology. We believe that increased productivity through technology transfer can only be realized by improving the overall climate for small business financing and new capital investment. It is also necessary to improve access by small business to market information and technological expertise - especially from non-government sources of information which carry higher credibility within the independent business sector. The C.F.I.B. also notes that the best way to transfer technology is by the interchange of people with the technological "know how" to small business - either through co-operative university/industry study programs or through increased small business interaction from procurement with large R. & D. firms and research organizations.

Part II - Innovation Through Small Business

The C.F.I.B. feels that too much attention has been placed on the need to increase R. & D. in Canada, compared to the "real issue" which is the commercialization of research which has already been completed. A

far more serious statistic is the very large and growing trade deficit that Canada suffers in technology-based goods and services.

In response to this growing problem the C.F.I.B. staunchly believes that a new science policy for the country must focus more on entrepreneurship and commercialization of research, rather than simply more R. & D. We may already have more technology than we know how to exploit. The creation and develpment of new technology products and technology-related services from small business are ultimately the only means of keeping Canada competitive and economically independent in this New Technology Age.

To catch up with this changing world economy, we must encourage new entrepreneurship at a rate unsurpassed in recent Canadian history. Recommendations put forward in this paper include the promotion of more entrepreneurship by scientists in universities and government; a simplified system of tax incentives (not grants) to increase industrial R. & D.; and the removal of other government barriers to innovation such as rigid policies of government procurement and regulation.

CONCLUSION

Viewed from the traditional perspective of strong government intervention in the economy, it is little wonder that the process of technological innovation seems so mystifying. We are moving through a turbulant era in history in which the rate of technological change defies all attempts to centrally quantify, regulate and control everything that is happening around us. Like the "primitive" computers before the microchip, our economic policies of even just ten years ago now seem very big, very slow, and awkwardly out of place.

In order to keep pace with this technological revolution, old methods of direct economic regulation and targetted subsidies are fast becoming obsolete. Technology information services need no longer remain the purview of remote central government repositories. Structural "monuments" to encourage innovation and training are becoming hopelessly out-dated and unresponsive to current societal needs. Direct government R. & D. assistance to high tech business can take almost as long to deliver as the entire commercial lifetime of the new products that these programs are designed to help develop.

Therefore to fully understand and maximize the economic opportunities caused by this technological revolution, government economic policies must try to mimic the decentralizing and liberating features of this new technology itself.

The rules of the new economy are really quite simple:

1. Government must help prepare society for the age of the entrepreneur.

2. Government must encourage more self-help, group networks and individual decision-making rather than the influence of a central economic program or plan.

3. Lastly, and perhaps most important of all, governments must have the courage to recognize the many elements of their own obsolescence, and resist the temptation to centrally plan the new decentralized economy that is emerging. Governments, however, can facilitate the process of adjustment by supporting entrepreneurship, new venture formation and a positive business climate for innovation and growth.

CANADIAN LABOUR CONGRESS

CANADIAN LABOUR CONGRESS CONGRES DU TRAVAIL DU CANADA

SUMMARY

OF

DISCUSSION PAPER

PREPARED FOR THE

NATIONAL FORUM ON A

NATIONAL SCIENCE AND TECHNOLOGY POLICY

WINNIPEG, JUNE 1986

The Canadian Labour Congress, which represents over 2 million workers, believes that economic policies must be built on full employment and fairness. A National Science and Technology Policy should reflect these two premises and be developed within the context of national economic initiatives.

A free trade agreement with the United States will not provide economic solutions for our science and technology challenges. In negotiating a comprehensive free trade agreement with the U.S., a wide range of economic management tools will be challenged by the Americans on the grounds that they are non-tariff barriers to trade. Regional development grants, agricultural support programs, subsidies to technology industries and government procurement programs may all be challenged. In other words, the tools of national economic management will be on the negotiating table. If we want to use grants and public investment to overcome regional economic disparities or diversify manufacturing bases we will have to get U.S. agreement that these measures do not involve non-tariff barriers to trade. If we want to use grants and regulations to preserve Canadian ownership in the communications industry and ensure the vitality of Canadian industries we will also need U.S. agreement that such measures do not involve non-tariff barriers to trade. In short, a comprehensive free trade agreement with the U.S. will limit Canada's scope for effective and independent political action to address economic issues especially in the area of science and technology.

The background paper refers to privatization and contracting-out to promote an increase in science and technology activity. The Canadian labour movement has consistently opposed privatization and contracting-out as policies that operate against the interests of working people.

Public sector employment can and should be used as a model to implement public policy objectives such as affirmative action including pay equity, bilingualism and regional development. Contracting-out means that the scope for implementing such policies will be reduced -- another example of the abandonment of an important tool of public policy.

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In the context of Canada's current high rate of unemployment, privatization and contracting-out should not be considered if they will result in job loss. Nor should they be considered if their effect will threaten wage and salary levels. To ignore or deny the interests of workers in considering these issues is public policy at its worst.

Government and industry tell us technological change is inevitable -- without it Canadian industry will become uncompetitive and our whole economy will suffer. Technological change which simply increases profits by displacing workers does not strengthen the Canadian economy. We are already experiencing the problems associated with unequal distribution of wealth and income in the country. While over a million Canadians are unemployed, Canadian corporations invest record-high profits not in the creation of new enterprises but in the manipulation of stock portfolios. The burden of tax continues to shift away from corporations toward individuals. In such circumstances we cannot afford to add thousands of Canadians to the unemployment lines.

It is in the interests of workers, employers and governments that technological change be introduced in the workplace in a smooth, non-disruptive manner with a minimum of adverse impacts. For this to happen there must be a commitment to share the costs and benefits equitably.

The collective bargaining process is the most effective method of sharing costs and benefits. In order to operate efficiently, collective bargaining requires a legislative framework. Labour legislation in all jurisdictions should be amended to provide minimum standards including: a comprehensive definition of technological change to minimize exemptions; one year advance notice of change; full disclosure of information; mandatory consultation between the two parties with no change introduced until an agreement is reached.

The improved productivity generated by technological change should be shared both at the workplace and in the economy in general through a system of shorter work time.

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The C.L.C. advocates a national science and technology policy, based on full employment and fairness both in its direction and content. That is, the goal of research and development should be socially useful, its benefits shared throughout the economy. Policies like privatization and contracting-out should not be implemented in the pursuit of research and development because of their negative impact on employment and working conditions.

We are pleased to see the Ministry of State for Science and Technology bring together the partners in this debate. We hope this will continue. Participation by the partners involved, both in the workplace and at the policy making level will ensure a smoother introduction of technology and ensure society as a whole shares in its benefits.

CANADIAN MANUFACTURERS ASSOCIATION

EXECUTIVE SUMMARY

To support long-term economic growth so that we can maintain our national prosperity, CMA believes that Canada needs a national science policy that focuses on assisting companies to use technology to improve our industrial competitiveness. This is critical as we move towards a freer trade environment. To encourage and assist federal and provincial governments to develop such a national science policy, this paper reviews what manufacturers have learned about industrial technology development and summarizes and updates previous CMA science policy recommendations.

Government policies have been fairly successful in supporting industrial technology development, as evidenced by the recent sustained growth of industrial R&D, averaging 18 per cent annually over the last seven years. In developing these policies, CMA believes that Canadian policy-makers have come to agree with a number of principles we have advocated. These include the need for a stable healthy economic climate and, in addition, for specific incentives with a long-term commitment. Canadian government support for industrial technology development should also be comparable to the level of support provided in competing countries. While support should be provided through a mix of mechanisms, these should always leave the initiative to companies, not to government, to decide what technology to pursue and what products to develop. Support mechanisms should also generally provide for technology development work to be done in industry.

These principles are incorporated into most government technology support programs, yet there is room for improvement.

TAX INCENTIVES

It is now well accepted that tax incentives are generally the most effective means to support most companies investing in technology. One of the two top priorities for a national science policy should be to improve R&D tax incentives so Canada has the required level and type that industry needs. Specifically this will require provincial governments to stop taxing federal R&D tax incentives and the federal government to extend 100 per cent refundability for unused R&D tax incentives to all companies. Any cap that limits the amount of refundable R&D tax credits should vary as a percentage of company R&D expenditures. The appropriate percentage should be established in consultation with industry. Most recent estimates are that R&D tax incentives cost government (and saved industry) $203 million for 1982. At today's level of industrial R&D spending, we estimate implementing our recommendations would increase government expenditures on R&D tax incentives by $191 million, $48 million of which would be borne by provincial governments and $143 million by the federal government.

GRANTS

No additional government revenues need to be spent on industrial R&D grants which currently cost federal and provincial governments $332 million. But there may be a need to reallocate funds among grant programs, phasing-out those that don't

win the endorsement of their clientele. To make this determination, we recommend each government should review their respective grant programs through a central government agency with participation from industry advisors. Reviews should be based on the following groundrules. Company and not government initiatives should determine what industrial R&D projects a grant funds. Grants generally need simpler administration and increased flexibility so the grant fits the need of the businessman seeking the support rather than the businessman having to fit the requirements of the grant. Internal conflicts in granting agencies that serve more than one purpose should be identified and eliminated so grants are judged only as to whether they make good business sense.

FUNDING UNIVERSITY ACTIVITIES RELATED TO BUSINESS NEEDS

The existing trend of improved collaboration between university researchers and businessmen should be continued. Initiatives to further improve collaboration should be left to those in the business and university communities with governments' role being to financially support such initiatives. To this end federal and provincial government funding agreements are required in three areas. **Providing the required funds should be the other of the top two priorities for a national science policy.** First, there should be reallocations of existing federal and provincial funding for universities to fully fund infrastructure and overhead costs that universities incur in doing business-related research sponsored by NSERC and companies so that such research does not cost a university money. Second, NSERC's second five-year plan, which by 1990 would increase its budget by $391 million, should be approved to strengthen the capabilities of universities to provide the scientific and engineering graduates industry needs. Third, there should be reallocations of existing federal and provincial government funding for universities to provide for the lifetime technical retraining graduates will require. Governments should begin discussions with industry and university representatives to determine what lifetime retraining programs and funding will be needed.

DIFFUSION OF TECHNOLOGY

The appropriate role for governments to play in improving technology diffusion in Canada needs to be determined in developing a national science policy. That role should include attracting foreign investment for the technology this can bring and endorsing the Patent Office becoming a more useful vehicle for disseminating technical information.

TECHNOLOGY CENTRES

The effectiveness of technology centres, the emphasis placed on this policy, how these centres are implemented and operated and how they can be better integrated with higher educational facilities should all be seriously reviewed in developing a national science policy. Specific attention should be given as to whether we need fewer new centres developed in response to company initiatives to replace the many existing centres that seem to have proliferated more in response to political than to market initiatives. Most importantly, any proposals for new centres should be initiated by their intended private sector clients. This would ensure that centres that are established are centres that industry needs and says it needs, not that government thinks industry needs. These recommendations should result in more effective technology centres that will cost governments less money.

GOVERNMENT R&D

In developing a national science policy for Canada, federal and provincial governments should establish the principle that government should not generally do industrial technology work for the purpose of transferring it to industry. The role of government laboratories should generally be confined to doing R&D to meet government departmental needs. Even then the government should, to the greatest extent possible, and more so than at present, contract-out its research requirements, particularly to the private sector. The R&D government needs to do should be better managed through peer review and use of external boards of directors for government laboratories. These measures should result in reduced funding requirements for government R&D laboratories which currently cost $1,529 million.

FUNDING

Improving the effectiveness of industrial R&D tax incentives and providing increased funding for university activities related to business needs must be established as the two top priorities of a national science policy. Required funds should come from reallocating existing government expenditures. First, reduce government funding of government performed R&D to levels closer to those in other OECD countries. This could save $581 million, approximately enough to implement our recommendations to improve R&D tax incentives ($191 million) and to approve NSERC's second five-year plan ($391 million). Such a reallocation of funds is justified as a better way to spend scarce resources and because the recommendations above for government R&D should result in reduced funding requirements for government laboratories. Second, additional funding from outside federal and provincial government science envelopes will also be required. Such additional funding for our recommendations concerning university activities should come from reallocations within federal and provincial government education spending envelopes. Although reallocations of expenditures by governments on government performed R&D and reallocations within educational funding should be sufficient to implement our recommendations, this may not be practical. To the extent this is so there should also be a general reallocation of government expenditures to implement our recommendations to improve tax incentives and to increase university funding. Such funding reallocations would be justified. Canada needs to, but does not, match the level of support provided to industrial R&D by our competitors. More importantly, increased expenditures to support industry's needs for R&D funding and for more competent technology graduates are demonstrably justified on economic grounds.

CANADIAN RESEARCH MANAGEMENT ASSOCIATION

THE VITAL INGREDIENTS OF A SCIENCE AND TECHNOLOGY POLICY FOR CANADA

Prepared for the "Canadian Forum on a National Science and Technology Policy", Winnipeg, June 8 - 10 (1986)

by

The Management Board of the Canadian Research Management Association

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Canada lacks an integrated policy for wealth generation and economic growth. Science and Technology policy must be recognized as an integral part of such an integrated policy for economic development. A number of principles that are the vital ingredients of a science and technology policy include:

1. Management leadership in both industry and government must be committed to the conviction that science and technology are fundamental to increasing the wealth of the nation.

2. The industrial sector is the key to a sound science and technology policy which is fundamental to Canadian economic growth and well being.

   Products and services and therefore technology must be market driven, and the build-up of skills must occur in the industrial sector if it is to be effective since it is industry that must carry the results into the market place.

3. The goal of science and technology policy must be the creation of world competitive businesses.

4. Industry must accept that aggressive pursuit of technological excellence is one of the keys to economic success.

5. Technology development should be built on Canadian strengths to develop niches (for exploitation on a world competitive basis) through acquisition and development of the best technology, developing unique products, high quality products, cost advantages, tying developments to natural resources, etc.

6. There is a need to train our future industrial leaders while they are still students in universities to recognize the potential of technology development and to provide them with the skills to manage this activity.

7. The most important role of universities which is to develop the scientists and engineers who will staff development activities in Canadian industry in the future needs to be strenghtened. In this regard NSERC has a key role as an interface between universities and industries in establishing long term training goals.

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8. Government funding of industrial R&D will be an essential element of science and technology policy if only to ensure that Canadian industry has the same level of support as that provided in other competing countries.

9. Governments should discontinue their role of developing technology which it independently thinks industry needs. The government is doing this in several ways - by operating its own industry-oriented development laboratories, and by setting up surrogate agencies in industrial development institutes and centres of excellence. In all cases, the true viability of such operations should be tested by having industry share significantly in their funding. Those that fail this test should be phased out.

10. The specific science and technology strategies which Canada decides to pursue hold the real keys to success. Since Canada is currently behind its competitor nations in science and technology, the country must make the strategic decisions using all the available skills and intellectual resources. Close interaction between industry, government and universities as a basis of mutual understanding and consensus building is therefore crucial.

11. The benefits derived from science and technology are long term. It is important that the country proceeds without any further delay.

CHEMICAL INSTITUTE OF CANADA

A SCIENCE AND TECHNOLOGY POLICY FOR CANADA

June 1986

The Chemical Institute of Canada

1. Support for science and technology should be directed to enhance Canada's basic industrial strengths: agriculture; wood products; metal products; petroleum products; high polymer products; transportation machinery; etc.

2. Fundamental research in natural sciences, applied science and engineering should be supported as the foundation on which advances in all those industries are based.

3. A substantially stronger association between industry and university should be fostered in order that each may have a better appreciation of the other. A closer relationship should influence the direction in which research advances and and bring about more rapid application of fundamental research in industry.

4. Fashionable words like "high tech" and "biotechnology" should not be allowed to divert government funds away from our basic industries into areas which have great potential, but can only be expected to have a long term effect. For example, our modern pulp and paper industry is "high technology". It is our largest earner of export dollars.

5. Most fundamental research is carried out in universities. Furthermore, graduate students are the source of highly trained personnel for research and for production in industry. Therefore substantial increase in support for university research should be the foundation for expansion of industrial research.

6. The Natural Sciences and Engineering Research Council has long been the mainstay of university research in this field. The freezing of the government grant to NSERC for five years without even an allowance for inflation in the 1986 budget is a serious blow to university research.

7. While the offer to match grants by industry to support university research is a good concept, it is unlikely to produce substantial funds unless the net cost of such investments by industry are decreased to about 10 cents on the dollar by suitable treatment of corporate income tax. If the rules governing these matching grants are appropriate for encouraging university researchers to seek donors and industries to seek people whose research they want to support they can be of great benefit to the advancement of science and engineering and to industrial expansion in Canada.

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8. The quantity and quality of research published in referreed journals by professors is best judged by peer assessment, as long practiced by NSERC. However, the value of the research for industrial production and sales is best judged by Canadian industries. Companies can influence the choice of research area by making financial contributions to specific university research fields. Informing appropriate departments in universities of the research needs of a company or an industry may influence the research interests of some professors.

9. The Chemical Institute of Canada has for over forty years "helped Canada to develop our intellectual capital", "acquire new knowledge" and "train highly-qualified personnel" through scientific and engineering conferences, seminars and courses. This will continue. We can also establish a portfolio for enhancing this activity.

10. Government laboratories can make a significant contribution to government-industry cooperation in science and technology if their scientists and engineers are required to submit proposals for projects to be financially supported to committees which have a substantial fraction of members from industries. It would help if industries were asked to submit suggestions for projects for government research laboratories.

11. Our educational system does not give most citizens even a modest understanding of the simplest concepts of chemistry, physics and mathematics. This is because the primary school curriculum does not provided it, and the teachers themselves usually do not have it. In the secondary school system, the freedom given to students to choose among many options makes it impossible to ensure that all secondary school graduates understand the basics in these fields. Only by having a set of core subjects that all students must take can this goal be achieved. Fear of things not understood, such as chemicals and radiation, leads to irrational demands which restrict technological advancement.

W. Howard Rapson, H.F.C.I.C.
President

CORPORATE-HIGHER EDUCATION FORUM

The following summary statement represents the position of the Corporate-Higher Education Forum, and of Bell Canada's Chairman and Chief Executive Officer J.V. Raymond Cyr in his role as Chairman of the Forum's Task Force which produced the report Spending Smarter (Investir plus sagement) in October 1985.

Introduction

In the fall of 1984, the Corporate-Higher Education Forum published its first major study Partnership for Growth: Corporate-University Cooperation in Canada. As a result of that research project, the Executive Committee established a Task Force of members to examine in more detail one of the issues identified for further action: the research and development required for the innovations that are expected to play such a significant role in ensuring the competitiveness of Canadian industry in coming years.

Spending Smarter is a result of that work. We believe that the following summary of its findings will be of interest to this National Science and Technology Forum and, we hope, to the country as a whole.

Summary

The picture of Canadian research and development investment patterns that emerged in Spending Smarter suggests that improved cooperation between universities and corporations represents a genuine and substantial opportunity for Canada to deploy its research and development (R&D) resources more effectively, and that this opportunity should be exploited aggressively.

Universities and corporations alike believe that cooperative R&D can offer substantial benefits in a variety of forms. Universities recognize that such cooperation can yield not only additional research resources but also new intellectual challenges which can result in society-wide benefits through the application of research. These add up to a more exciting and challenging environment for teachers and students which in turn leads ultimately to better educational programs.

Corporations recognize that better educational programs mean better graduates, leading in turn to greater competitiveness both within Canada and globally. They also recognize that universities are an excellent and convenient source of technological expertise, which they either cannot afford to develop in-house or cannot justify as a permanent department.

Canada's economy also benefits substantially in that university R&D is a key source of the technological advances that protect our existing industries - challenged as they are by cheap labour and other resources in developing countries - while creating new jobs in the new industries such technological advances spawn. Outstanding examples of job-creation arising from technological achievement in major universities and corporations exist today in the United States and the United Kingdom. In Canada we are only beginning to reap such benefits; Kanata is, perhaps, our leading example.

All these benefits suggest that cooperative R&D offers a significant opportunity to improve Canada's sub-standard performance in the worldwide R&D stakes. (Canada's R&D spending has stalled at about 1.5 percent of gross domestic product - consistently below the levels in other developed countries.) Cooperative R&D also offers an opportunity to overcome, at least in part, the serious shortcomings in government research spending (which consumes a disproportionately large share of Canadian R&D dollars). Although government-funded research has resulted in some technological advances, many believe that research performed in government laboratories has contributed little to the advancement of Canada's economic competitiveness, either because of poor project selection or because of poor transfer of results into the commercial arena.

Despite perceptions of the important benefits which are available through cooperative R&D, activity is limited. Spending Smarter confirms the view that there are two major barriers; one cultural, the other logistical. "Cultural barrier"

relates to the differences between the academic and corporate communities in terms of R&D goals, ways of doing things, attitudes toward time and budgets, and definitions of success. The "logistical barrier" refers to the practical difficulties researchers in both communities encounter in identifying and communicating with their counterparts to initiate cooperative activity.

On a more positive note, the members of the Task Force found that cooperative R&D was being conducted to the satisfaction of both univesity and corporate participants. Two conditions appear to be necessary if such healthy cooperation is to continue to flourish and grow. First, leaders on both sides must create a more supportive environment, within which it is easy to deal with cultural or institutional differences. Second, organizations must invest the time and money to get researchers talking to researchers. Talking leads to specific project opportunities - and that is the payoff.

There is growing evidence that the climate is right for cooperative R&D to flourish. A consensus is emerging that there will be a tilt back toward basic research - the forte of the university - as corporations recognize the limitations inherent simply in seeking further refinements of existing technologies. At the same time, there is a growing recognition among academics that working with corporations does not necessarily imply an erosion of independence and integrity; even in the most intensely active cooperative relationships, contract work accounts for only a small percentage of a university's overall research budget.

The report does not mean to play down organizational barriers. Some are so deeply entrenched, with solutions so radical to an organizations's culture, that only leadership intervention will change things. Motivating researchers on both sides would be a beginning. At present, cooperative R&D is not likely to do much to enhance the career of a researcher on either side. Basic changes in evaluation systems are necessary to remove this barrier.

The report encourages Canadian governments to act as a source not only of money but also of ideas for both corporations and universities. It suggests, for instance, that:

- o The government should re-examine its policies along two broad lines -- its own direct spending on R & D; and its tax and direct grant policies in support of research and development done outside government;

- o It should sub-contract more of the research being performed in its own laboratories;

- o More should be done to ensure that government research results find their way systematically and efficiently into the commercial sector.

The Task Force felt too that government should revise its tax incentives, university funding and block grants to take into consideration:

- o Small companies, which badly need R & D but which, for a variety of reasons, cannot benefit from tax incentives;

- o The need for universities to be given some incentive to cooperate actively with corporations;

- o The encouragement of universities and corporations to increase their professional competence in specific, relevant areas of research; and

- o The need to address Canada's research talent shortfall.

Conclusion

This Forum for the Development of a National Science and Technology Policy stresses the importance of developing and acquiring new knowledge. The Corporate-Higher Education Forum in its study Spending Smarter proposes ways of developing and acquiring new knowledge more effectively through closer collaboration amongst universities, corporations and governments.

ELECTRICAL AND ELECTRONIC MANUFACTURERS ASSOCIATION OF CANADA

Electrical and Electronic Manufacturers Association of Canada

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SUMMARY OF A PAPER ENTITLED CREATING THE SCIENCE ENVIRONMENT - MAY 1986

INTRODUCTION

The federal government's Science Policy, and its commitment to a policy, is a crucial concern of industry. Since the importance of this matter has largely had lip service over the years, we feel that a concommitant to the announcement of a policy would be some means of assuring for it the priority that is attached to major initiatives. Strong support and representation at the highest level is needed to create the emergence of Canadian engineering and science as a driving force in the economy.

A Science Policy should not address itself solely to pure research. The directions taken in industrial research and development policy will be crucial to Canada's international trade performance, especially as we progress to a free trade environment.

Increasingly, Canada's economic well-being and the standard of living of our people will depend, not only on our declining natural resources, but on our ability to compete, both at home and abroad, in technology and knowledge-based industries.

INDUSTRIAL RESEARCH AND DEVELOPMENT

The Electrical and Electronic sector is a heavy R & D spender relative to most industries but obviously its expenditure is still not enough to ensure its own future health. In 1984 many companies in the sector spent over 4% of gross revenue on R & D - more than triple the national average. Other companies in this sector experiencing strong growth are spending in excess of 5% and up to 20% of gross revenue.

To bring R & D spending even up to the 5% level across the sector is not realistically possible without substantial public support, particularly in

enabling technology contracts*. The enabling technology contract is an attractive solution since it could be coupled with a redistribution of government R & D expenditures.

An effective R & D strategy must be comprehensive and must complement the entire manufacturing and marketing process. Industrial R & D must be market-driven, constantly evolving to satisfy ever-changing international and domestic requirements.

ENABLING TECHNOLOGY

One of the main reasons that government support to industrial development is lower in Canada than in some other industrialized countries is because major programs do not take place under government contract where the development of industrial capability is seen as a major and necessary component of the investment. In other industrial countries with which we compete, non-tax support represents as much as 33% of industrial R & D. In Canada, it is about 12%.

This is clearly an opportunity that we are missing in Canada. Government contracts are often placed on a very competitive basis where no allowance can be made for the substantial development costs that may be required to create that particular manufacturing capability in Canadian industry. The funding of these kinds of development costs under such major contracts is widely practiced in other countries, does not attract the attention that grants or tax incentives do, and is not considered unfair competition.

Canada must make better use of government purchasing power to build technical industries. Development work and technology contracts should go to industry - not government labs.

INCENTIVES, PROCUREMENT, AND GRANTS

About 16 cents of every industrial sales dollar is deposited in government coffers in the form of Federal sales tax, income tax, and corporate tax,

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*These are contracts where the only deliverable is a demonstration of technological capability.

whereas secondary manufacturing industry, on average, retains earnings of about 4 cents. With such an uneven partnership, industry depends heavily on government to take a significant part in its ongoing development, particularly in respect to research activities and the application of scientific developments. Such government participation is widely practiced in the OECD countries but has yet to achieve similar levels in Canada.

As part of government's cooperative role with industry, we believe that this assistance can be provided in five ways:

A. Through contracts for the supply of technological capability.

B. By direct grants.

C. By providing tax incentives for research and development.

D. Government Procurement.

E. Mechanisms directed to companies which are not sufficiently profitable to realize tax credits.

Tax incentives are usually not as beneficial as they seem because of taxation. Changes must be made to the Income Tax Act to allow the full value of incentives to be realized. Provincial governments must give up their windfalls from the taxation of federal R & D incentives or, instead, provide some offsetting benefit to R & D performers in their province.

INVESTMENT CAPITAL

To achieve substantial industrial growth in the next decade, industry requires large amounts of investment capital from corporations and individuals. For small, fast-growing companies this is often a serious problem. It could be solved by a national stock savings plan similar to that adopted by Quebec, with a sliding scale of tax write-offs for investors.

MANPOWER DEVELOPMENT

A new covenant must be struck between the universities and business. The basis

for the new covenant should be the provision of industrial experience for university staff, university exposure for industrial staff, and a re-emphasis of the fundamentals in university education.

While additional funding may be helpful, it would not reach the core of the issue. An adequate amount of Canada's Gross National product is being devoted to the education system at present. Canada spends a greater portion of its national wealth on education than any of its major industrial competitors. Rather, the allocation of these resources within the system must be corrected as must the ability of the system to meet change.

We believe that strategic planning is the approach required for educational reform and that a strategy for technical education and skilled manpower development must be created that is consistent with a National Science Policy. Strategic planning should address issues such as faculty renewal, capital expenditures, emphasis on key areas such as engineering and computer science, a market-type system for funding universities, and methods to create greater adaptability.

We believe also that there is a level of technological illiteracy, with its roots in the high schools, being propagated through the university system. It should be a major objective of a National Science Policy to improve the level of scientific and technological literacy in the population.

GOVERNMENT/INDUSTRY/UNIVERSITY INTERACTION

Corporate R & D centres have some difficulty transferring technology to the manufacturing operation. Government laboratories are even less effective not only because of the physical remoteness but because of the organizational distance that isolates their activity from its applications. The likelihood of government laboratories becoming more useful to industry is remote since technology is moving in a direction that favours integrated activity. Nonetheless, efforts must be made to get the staff of government laboratories and university researchers closer to industry by having them spend periods of time working in industry.

FRASER INSTITUTE

A BRIEF REFLECTION ON
"Building on Our Strengths"

Kristian Palda, Queen's University
and Fraser Institute*

June 9, 1986

INTRODUCTION

The MOSST background paper "Building on Our Strengths", and, indeed, the whole theme of the Canadian Forum on a National Science and Technology Policy (Winnipeg, June 8-10) builds on two fundamental premises. The first is that Canada's scientific and technological-innovative performance is unsatisfactory and the second, reposing on the first, is that a national, government-launched policy can remedy the sorry situation. Thus the Forum is invoked to discuss "the parameters" of a national science and technology policy.

Here it will be argued that both premises are patently false. There is therefore no need for yet another attempt at industrial policy -- parading in technology clothing -- and especially not by a conservative federal government committed to reducing rather than increasing the tax burden of Canadians.

UNIVERSITY AND INDUSTRIAL SECTOR PERFORMANCE IN SCIENCE AND TECHNOLGY

a) University Performance

Among a number of questions that this Forum is to debate, one stands out for its thorough imprecision:

> Is Canada getting maximum beneits for money spent on university research? If not, what...

What is the meaning of <u>benefits</u> flowing from university research? Is it the number of refereed articles per research dollar, or the number of citations, or the number of patents, or the number of technical innovations launched, or the sales or savings therefrom per dollar spent? Will analytical diversity weigh less in the appraisal than

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*The views expressed here may not conform singly or collectively with those of the members of the Institute; Queen's has no official position on these issues.

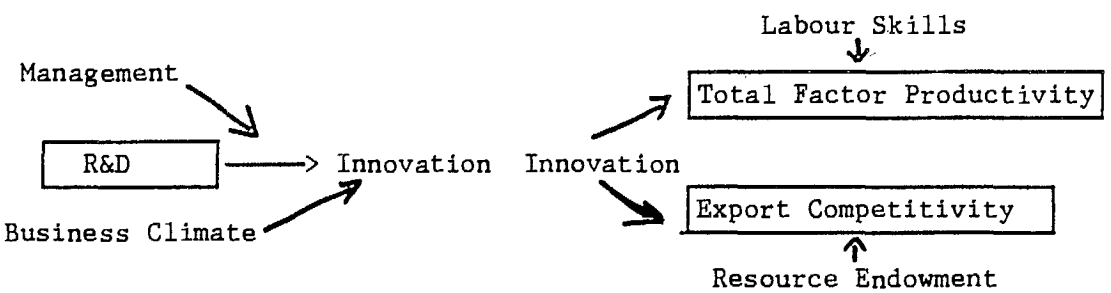
microbiology ? Who is bold enough to make these measurements and pronounce performance unsatisfactory? NSERC, NRC, the Science Council, MOSST or the Canadian Manufacturer's Association?

b) Industrial Performance

The definition of benefits from industrial innovation is conceptually easier than in the case of university research. It is the enhancement of revenues or decrease in costs of the firm or the industry. Yet the difficulty of estimating the net impact of technological innovation upon return on investment leads many observers and most governments to rely on substitute measures of performance, on "input" or "output" measures of innovation. As Figure 1 makes it clear, R&D is but one of several influences on the realization of a successful innovation; similarly, more than just innovation is responsible for trade advantage or productivity improvement.

Figure 1 (1)

"Input" and "Output" Sides of Innovation



Even these proxy measures of technical-innovative performance are, however, constructed and used in too simplistic a manner:

R&D intensity: measured on the economy-wide level as GERD/GNP(2) and then compared to other OECD partners (Canada, 1984, 1.35%, Austria 1.23, France 2.15, UK 2.27) totally disregards the sectoral structure of these economies as well as of the defence burdens carried by them(3).

: measured on the industry level as R&D/Output disregards suppliers' R&D embodied in imported inputs, government and university research undertaken on behalf of the industry and, above all, the massive (on the order of $1 billion) invisible, i.e. unpaid for, importation of R&D results from multinational affiliates(4).

Trade Competivity: given the misleading measures of research intensity used in the definition of technologically-intensive

industries, the consistently excellent trade performance of resource-oriented industries is falsely attributed to nature's endowment rather than to the massive infusion of publicly funded research.

: world trade shares of Canadian exports naturally decline as trade widens explosively, while sales expand; trade deficits, to be properly compared over time, must be deflated with constant dollars or "normalized"(5).

When these two proxy measures of innovative performance are properly estimated, Canada and its industrial sectors place in no way below OECD standards.

GOVERNMENT PERFORMANCE IN SUPPORT OF INNOVATION

a) Actual support of innovative thrust by government financing --

as measured by percentage of GERD financed from public sources (Canada, 1984, 54.5%, Austria, 1981, 43.8%, France, 1984, 54.4%, UK, 1983, 50.2%)

as measured by percentage of BERD financed by government (Canada, 1983, 11.2%, Austria, 1981, 7.4%, France, 1983, 22.4%, UK, 1983, 30.2%, Sweden, 1983, 10.4%) --

documented by OECD statistical comparisons seems perfectly adequate. Direct assistance to large-scale non-performers (AECL, CCI, Challenger-Canadair) and $2 billion plus in Scientific Research Tax Credits appears overly generous.

b) Tax structure and responsiveness of industry.

McFetridge and Warda, writing before SRTC, offered persuasive evidence that Canada is the most generous of 11 comparable countries in offering fiscal and grant stimulus to private sector R&D(6). If Canadian industry's R&D spending is nevertheless officially considered inadequate, the blame must lie in the sluggishness of response toward the incentives offered to industry. Studies by Bernstein(7) and Mansfield & Switzer(8) do indicate that the elasticity of response to fiscal and subsidy incentives is quite low. A definitive judgement must await the economic post-mortem of one of the most expensive governmental blunders in Canada's history, the Lalonde-initiated scientific research tax credits. This was a natural experiment on the order of $2 billion whose outcome will indicate, by 1989, how much of that outlay found its way into legitimate industrial research.

A NATIONAL TECHNOLOGY POLICY - YET AGAIN?

Given that private sector innovative performance cannot be shown to be inadequate on grounds of international comparison and given that taxpayer support of industrial innovation was, if anything, on the side of generosity there appear few grounds for a tax-supported mobilization of Canada's technological resources.

It may be that elective officials have no history-related memories, but participants in this Forum come also from the ranks of the public service, industry and universities and they will remember an Ottawa conference called Canada Tomorrow, staged within living memory, and opened by the then prime minister. They will also recall the 1981 MacEachen budget paper Economic Development for Canada, the 1982 Don Johnston express refutation of it and declaration of a new policy destined to make Canada "a major player in the technolgical revolution that is sweeping the world", and the 1983 Lumley utter retreat from industrial policy making (1, pp. 5-6). Finally, they will also remember the estates-general of French science called in 1982 by the freshly installed socialist government of France, the sweeping new science and technology policies announced in that country and approvingly referred to by Ed Broadbent, the generous budgets allotted, and the retreat from all this glory by 1984 in the face of economic reality.

Should we not admit into our planning lessons from history?

MINING ASSOCIATION OF CANADA

SCIENCE, TECHNOLOGY AND INNOVATION
IN
THE MINERALS AND METALS SECTOR

EXECUTIVE SUMMARY

Over the past years, the mining industry had to go through a very difficult situation marked with plummeting consumption and commodity prices. To survive, companies had no choice but to apply stringent cost control measures and improve productivity.

Second to tighter management, innovation, with the introduction of changes and improvements in ways and means of carrying out mining, has been the key factor in increasing and achieving better productivity.

To stay the lowest-cost producers, productivity improvements must be realized on a continual ongoing basis and implementation of new technology is crucial in this regard. This is an area where Canada and our industry could and should do more and this is why the MAC is proposing the formation of "Centres of Innovation for Mining Systems" like the ones that have been established in the United States.

Yet, several useful initiatives are conducted but industry, governments, and universities are having a hard time organizing for closer and more efficient cooperation.

The industry believes that it is in the best position to provide the necessary leadership and is indeed prepared to take on that role through The Mining Association of Canada.

Our challenge is to put the following elements together:

- Emphasis on university research;
- The need for closer identification of university research with successful innovation;
- More cooperation and support from the industry in directed work with universities and government institutions;
- Sharper focus on industry priorities from government laboratories and granting agencies;
- Governments support of appropriate applied work in universities and industry through, among other means, grants and contracts.

To achieve these objectives, the MAC has launched a technology coordination initiative in proposing the establishment of an institutional structure dedicated to planning, promoting, priorizing, and carrying out a coordinated approach to mineral industry innovation.

Under the guidance of The Canadian Institute of Advanced Mineral and Metal Technology (CIAMMT), being made up of eminent persons in the sector, the scheme would also comprise several university-affiliated specialized technology centres which, along with government laboratories, would be expected to direct and to coordinate their efforts along the lines agreed by the CIAMMT.

It is anticipated that the main source of funds for operation will be provided on a matching basis by government and industry. "Sponsors" are defined as both of these funding agencies plus the host and affiliated universities.

For the MAC, the elements underlined above represent the essential principles upon which a new national science and technology policy should be developed.

NATIONAL CONSORTIUM OF SCIENTIFIC AND EDUCATION SOCIETIES

The National Consortium
of Scientific and Educational Societies

Le Consortium National
des sociétés scientifiques et pédagogiques

1001-75 Albert, Ottawa, Ontario K1P 5E7 Tel.: (613) 237-6885

The Elaboration of a National Science and Technology Policy: The Participation of the Scientific Community

Brief submitted by

The National Consortium of Scientific and Educational Societies

to

The Minister of State, Science and Technology

at the

Canadian Forum on National Science
and Technology Policy

Winnipeg, June 8-10, 1986

By: Clément Gauthier, Ph.D.
President

The National Consortium of Scientific and Educational Societies (NCSES) welcomes the joint initiative of federal, provincial and territorial ministers of science and technology, to organize the "Canadian Forum on a National Science and Technology Policy". We are most happy to take part in such an historical event which, we hope it, will give an impulsion to our long awaited national policy on research and development (R & D).

The National Consortium is composed of 30 organizations representing some 55 000 researchers and university teachers, as well as the 400 000 members of the Canadian Federation of Students. The Consortium has been active since 1976. Its main purpose is to share information and exchange views on issues of concern to the scientific and student community with respect to Canadian policies on R & D and post-secondary education. The following organizations are members of the National Consortium of Scientific and Educational Societies:

- Association for the Advancement of Science in Canada
- Association of Canadian Universities for Northern Studies
- Association of Universities and Colleges of Canada
- Biological Council of Canada
- Canadian Association of Graduate Schools
- Canadian Association of Physicists
- Canadian Association of University Business Officers
- Canadian Association of University research Administrators
- Canadian Association of University Teachers
- Canadian Bureau for International Education
- Canadian Council of University Biology Chairmen
- Canadian Federation for the Humanities
- Canadian Federation of Biological Societies
- Canadian Federation of Students
- Canadian Geoscience Council
- Canadian Institute of Food Science and Technology
- Canadian Medical Association
- Canadian Psychological Association
- Canadian Society of Clinical Investigation
- Canadian Society of Microbiologists
- Canadian Society for the Study of Education
- Canadian Union of Educational Workers
- Canadians for Health Research
- Chemical Institute of Canada
- Council of Canadian University Chemistry Chairmen
- Institute of Electrical and Electronics Engineers-Canadian Region
- Professional Institute of the Public Service of Canada
- Science Council of Canada
- Social Science Federation of Canada

Question 1 a: Is Canada getting maximum benefits from money spent on university research? If not, what steps should be taken to improve the situation?

No, because a portion of the federal transfers under the Established Programs Financing Act (EPF) to Post-secondary Education is used by the provinces for other sectors of activity. These funds are needed to cover the so-called "indirect costs of research", such as space, utilities and salaries. Moreover, the Federal Governement recently announced a unilateral cut to EPF amounting to a cumulative total of $5.5 billion by 1990. For fiscal year 1986-87, this cut amounts to $102,4 extra million for the Federal Government. The budgets of the granting agencies increased by $25 million while the full funding of the Five-Year Plans would have required $258,1 million more. As a result of successive cutbacks by the provincial and federal governements, the Canadian university system is on the brink of disaster: since 1977-78, full-time equivalent enrolment in Canadian universities has increased by 24%, while real expenditures per students in constant dollars have decreased by 18%.

RECOMMENDATION

In order to prevent the provinces to further retrenchment of the support to the universities, the Federal Governement should not proceed with its proposed modifications to the EPF (Bill C-96). Rather, there should be a First Ministers' meeting called to discuss solely the state of higher education in Canada

RECOMMENDATION

Being given that the basic research done almost exclusively in universities is, and should be a federal priority, the National Consortium recommends that the new Standing Committee of the House of Commons on Research, Science and Technology study both the direct and the indirect costs of research, as well as other matters deemed pertinent to post-secondary education that are related to university research, either directly or indirectly.

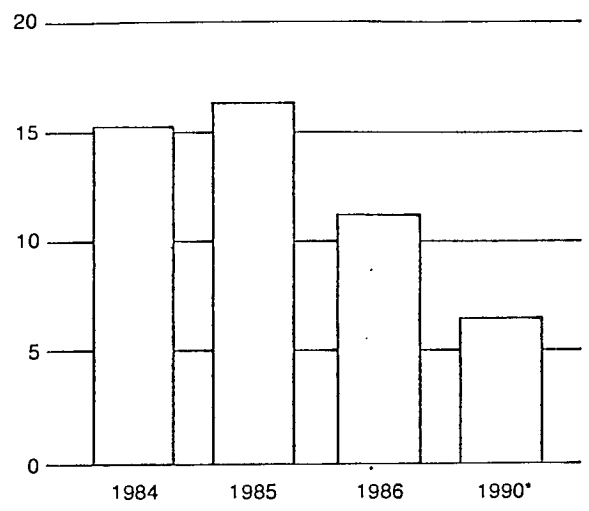
Question 1 b: If new money were to become available, should it be used for university research?

Yes, since (i)"University laboratories can and should be leaders in the area of basic research and that...(ii) post-secondary institutions remain our prime source of the trained personnel needed by a dynamic society" (David G. Vice, President of Northern Telecom Ltd, Building on Our Strengths, MOSST, 1986).

Unless basic research (R) gets the critical mass of investments that is required, Canada will miss the opportunity to develop (D) its tremendous potential.

In Canada, the three federal granting councils are the primary supporters of university research, under 1% of total current university expenditures being provided by corporate support of university R & D (Building on Our Strenghts, MOSST, 1986). Moreover, a Conference Board of Canada study published in February 1986 showed a substantial reduction in the rate of growth of corporate R & D spending intentions for 1986. As the following diagram illustrates this trend carries through to the 1990's. On the basis of these preliminary remarks , we would like to proceed with our assessment of the five-year funding plan for the granting councils which the government made public last February.

Chart 2
R and D Spending Intentions, All Respondents



*Average annual compound rate of growth from 1986 to 1990.

Source: The Conference Board of Canada.

Assessment of the Funding Plan for the Granting Councils (Feb. 1986)

Firstly, we welcome the government's commitment to provide the granting councils with stable, though inadequate, funding at a level equivalent to their total 1985-86 budgets.

Secondly, the increases of 4%, 4% and 10% originally allocated to the MRC, NSERC and SSHRC respectively for FY 1986-87 were perceived as a step in the right direction. As it turns out however MRC will receive only a 2% increase as a result of a 2% cut imposed by the Department of Health and Welfare. According to our understanding originally this 2% budget reduction was not to be applied to MRC. Moreover, since the February announcement

NSERC has had to assume new responsibility for part of the funding of a programme which until recently had been funded and administered by the Canadian Forest Services. NSERC must now transfer to the Canadian Forest Services programme some $3.6 annually during the next two years, without being provided with additional resources, thereby bringing its effective increase down to 2.8% from 4%. Such an extension of responsibility without additional resources constitutes an unacceptable practice which seriously hinders the planning activities of the Councils, not to speak of inducing the Canadian public in error concerning the increases actually allocated to R & D.

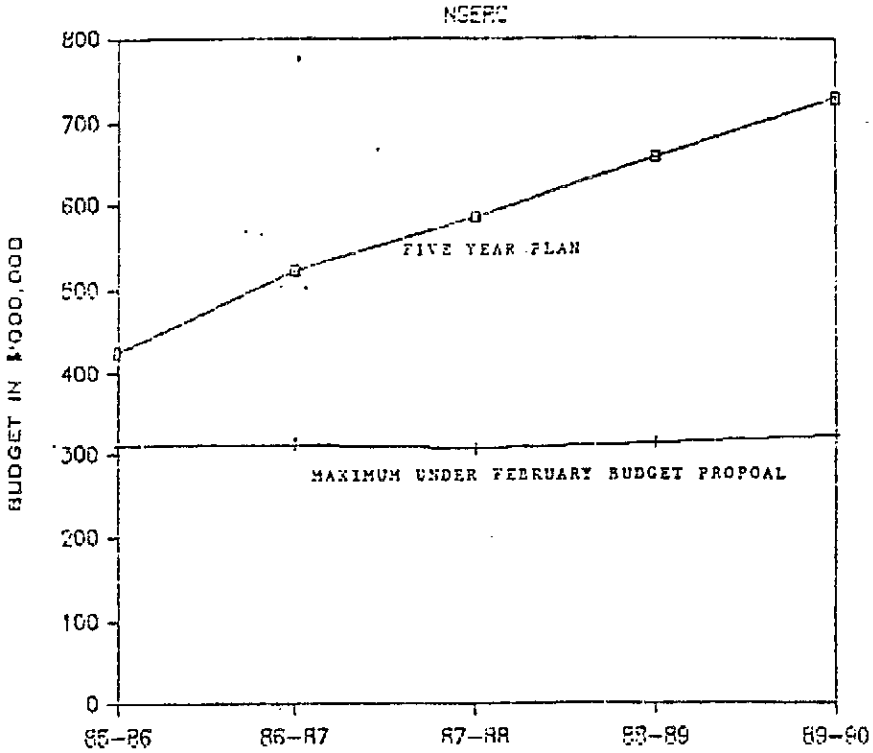
Thirdly, we wish to express the following reservations regarding the funding plans. On the one hand, all figures are in current dollars and no provision is made for inflation, which will probably be around 4%. On the other hand, according to the current funding plan, any real increase in the Councils' budgets must come through private sector contributions, which will then be matched by the federal government. The Conference Board of Canada study cited above establishes that the projected corporate investments (under 1% of the university expenditures) in R & D will decrease in the years to come. Moreover, although the guidelines for implementing the new policy are not yet known, the indications contained in the February 1986 Budget Papers lead us to believe that the programme might be conceptually flawed and that it may not be able to meet its declared objectives.

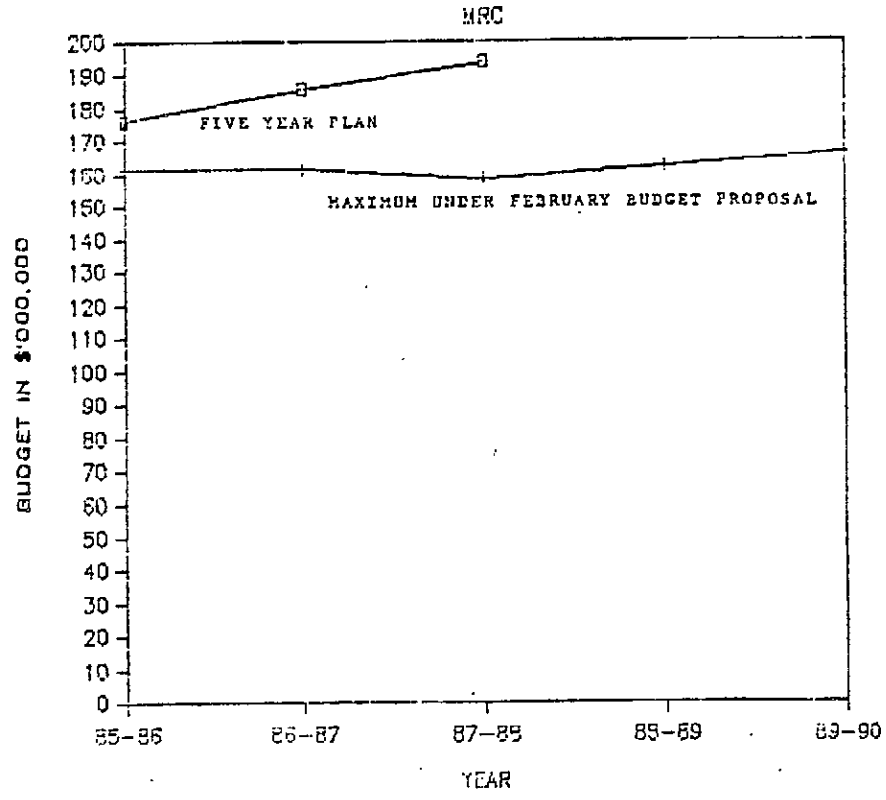
A case in point is the exclusion of the Social Sciences and Humanities from the definition of "scientific research" for the purpose of the Income Tax Act. Even if this exclusion was done away with, it is not likely that the private business sector would be willing and able to support research in the social sciences and humanities at a level proportionately comparable to that of the natural sciences. To a lesser degree , medical research faces a similar problem in view of the fact that the only significant source of private funds is the pharmaceutical industry, which is cutting back on its support of R & D performed in Canada. In both instances it is of paramount importance that a literal definition of the private sector be avoided.

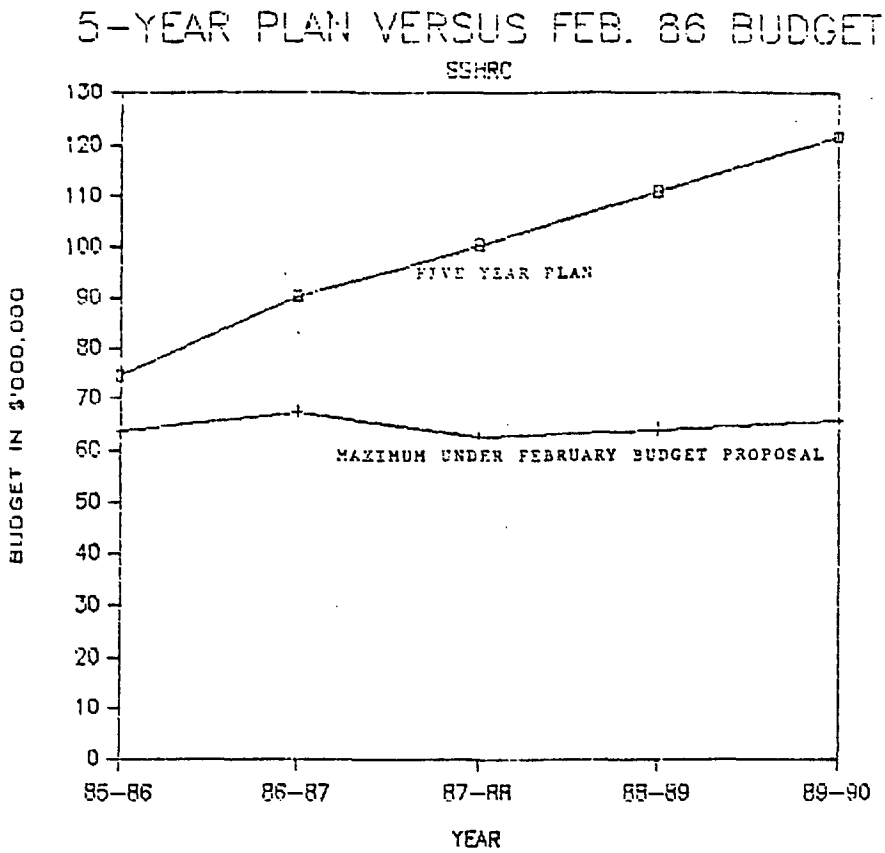
Fourthly, the Consortium is extremely disappointed that the government appears to have discarded the very carefully prepared realistic Five-Year Plans of the three granting councils. The unanimous support of the academic community for these Plans as well as the extremely good record of the granting agencies with respect to the administration of their programmes and the disbursement of public funds are the best guarantees the government could ask for. Without Five-Year Plans, it is difficult to see how our national objectives in terms of R & D can be pursued.

The graphs shown below illustrate the increasing discrepancy between the Councils' budgets under the Five-Year Plans and the maximum amounts possible according to the February 1986 funding plan. We have included the matching funds that would eventually be granted by the federal government. We have not, however, included the private sector contributions. These latter contributions will in effect be tied to specific research contracts and therefore will not be available to the research councils for the support of their basic activities.

5-YEAR PLAN VERSUS FEB. 86 BUDGET







ALL FIGURES IN CONSTANT 1985-86 DOLLARS
INFLATION ASSUMED TO BE 4% PER YEAR

MAXIMUM MEANS APPROVED BUDGETS PLUS BUDGET INCREASES PLUS FULL FEDERAL MATCHING OF PRIVATE SECTOR CONTRIBUTIONS BUT DOES NOT INCLUDE PRIVATE SECTOR CONTRIBUTIONS

To summarize, the Consortium is in favor of an increased participation of the private sector in the funding of research in Canada. However, it would be extremely dangerous to expect the private sector to undertake, to any substantial degree, in the short-term, what is the primary responsibility of the federal government, namely the support of a healthy, vibrant academic research community. It is the future of our country which is at stake.

RECOMMENDATION

We therefore urge the Federal Government that a decision be made on the Five-Year Plans submitted in the Fall of 1985. We also recommend that, as a strict minimum, the base budgets of the granting councils be adjusted for inflation in 1986-87 and thereafter.

Question 1 c: How can we foster better linkage between the private sector and universities?

The Consortium is a unique forum to exchange views with the scientific community in Canada. On April 2, 1986, we invited Mr Roberto Gualtieri, as representative of MOSST, to exhange views on the new Matching Programme. This fundamental step was followed by written communications between MOSST and many member organizations of the Consortium. Various workable schemes of implementation have been put forward, in a trial to optimize the impact of the programme. The Consortium already committed itself to take part in the consultation process that will take place after the release of the draft regulation by Finance Department.

In addition to the respective Presidents of the granting councils, the Consortium intends to invite the President of the Science Council of Canada as well as members of the Business community to take part to coming meetings.

Question 3: How could Canada contribute expertise to international development and cooperation?

The Benefits Canada Gains from International Students (International Students and Canadian Foreign Policy, A Brief presented by the Canadian Bureau for International Education to the Joint Committee on Canada's International Relations, November, 1985)

Canada derives considerable benefits from the presence of international students. First, they are obliged by law to bring with them sufficient funds to cover all of their costs while in Canada, an amount which ranges from $7 000 to $15 000. per year per student, depending on the province of study. With a population of 50 000 to 55 000 international students, the gross inflow is at least $500 million. They also pay property and sales tax.

Second, there are clear academic benefits. According to Gordon MacNabb, then president of NSERC, "graduate training in some key disciplines has only survived during the past decade as a result of an influx of visa students". He goes on to say that "in some academic areas there is a shortage of qualified Canadian students willing to undertake graduate study...This lack of Canadian candidates jeopardizes the future of advanced research in these areas. Thus, the availability of visa students to pursue graduate work in these areas helps to maintain the strenght of the research enterprise on which...industrial development depends".

Finally, international educational exchange is an essential part of friendly relations among countries. Students abroad develop a familiarity with their host society and with its subtleties, through working contacts and personal relationships with classmates, researchers, professionals and the business world. When the students return home, these acquaintances may serve as essential links in the flow of ideas, information and technology, leading to stronger cultural and commercial links.

Unfortulately, current trends in our treatment of international students send the message that Canada is not interested in fostering these benefits. A lack of clear policy, limited scholarship assistance, huge variations in tuition fees, program restrictions, enrolment quotas, overseas recruitment practices by so-called "visa schools", restrictions on employment, and a disturbing lack of information about international students and of support services (including health care), do nothing to attenuate this impression. Nor does the recently proposed cost-recovery charge for processing immigration documents, which will impose a handicap on international students, especially those from countries which have limited access to foreign exchange. Canada is pursuing a course increasingly at odds with our own best interests.

RECOMMENDATION

The Consortium recommends that Canada develop a clear, coherent and long-range policy towards international students. The Special Joint Committe on Canada's International Relations should hold hearings on this important issue. In addition, this question of international students should be on the agenda of the First Ministers' meeting on higher education requested above by the Consortium.

Question 9: What can we do to help Canadians deal with the dramatic sweeping changes in all aspects of life which technological change will confront us with the next two decades?

We could not emphasize enough the importance of public awareness of R & D as the cornerstone of the implementation of our national policy on R & D.

We believe that the Science Council of Canada has a crucial role to play with that respect, a role that it has already undertaken with the very limited means at its disposal. The Council is the only body that can elaborate in a comprehensive on objective manner the integration of research in Canada and that can document it. Its work is valued by the Canadian public and by the scientific community which is now aware of its strategical importance for the future of our country.

The scientists also have an important role to play in public awareness of their respective research and of their pertinence for the future of Canada. This is the main reason for the regular annual meetings organized by the Consortium with canadian parliamentarians. In addition, representatives of the Consortium did appear before the Standing Committee of the House of Commons on Research, Science and Technology, on May 28, 1986, to express their views about the mandate of the Committee and the federal policies on R & D.

There is no popular national science magazine available to Canadian public, making the promotion of the public awareness of science most difficult. Aware of this serious handicap, the Consortium recently called upon its member organizations to support the initiative of the Association for the Advancement of Science in Canada (AASC) in that matter. We would invite the other organizations as well as the government to participate to this joint effort and to get in touch with AASC for details.

PULP AND PAPER RESEARCH INSTITUTE OF CANADA

NATIONAL SCIENCE AND TECHNOLOGY POLICY FORUM

Peter E. Wrist

Pulp and Paper Research Institute of Canada

Paprican believes that a National Policy for Science and Technology is needed

a). to provide direction, continuity and cohesiveness to the Government's programmes in support of these important areas.

b). to improve the public's understanding of the issues involved and the importance of the role that science and technology must play in the future economic health of the Canadian economy,

c). to provide the guidelines and a framework within which coherent, stable programmes of cooperation between governments, universities and industry can be nurtured and sustained.

Such a policy should build upon the special strengths of Canada and should avoid encouragement of competition in every possible field of science or technology. It should also take into account the diverse and geographically widespread nature of the country, turning these characteristics into advantages rather than liabilities. Canada has no unique advantages over other countries in the development of new High Technologies but it does

have special opportunities in which to seek competitive advantage in their application. Examples include communications, transmission of electric power and transportation over long distances. Canada also has large natural resources in which application of High Technology will be needed in the future if these national assets, on which a large number of remote communities totally depend for their livelihood, are to remain competitive in world markets.

There is vital distinction between the generation of new knowledge and the the process of industrial innovation which the background paper fails to clarify. The implication throughout the paper appears to be that the progression from new knowledge to successful innovation is a direct and linear one. This is far from the case in real life although there are very important interactions between the two enterprises. Their distinctions must be kept clearly in mind when we consider the desirable goal of increased interaction between industry and universities on which the paper places strong emphasis. The scientist seeks new knowledge at the edge of existing knowledge. The innovator seeks to exploit the opportunity of providing a commercial solution to an existing or perceived need. He does so with the aid of existing knowledge whenever possible. It is only when the

innovator lacks the knowledge to achieve his desired goal that he turns to the scientist for help or when the scientist realizes that his new understanding provides an hitherto unavailable solution to an identified need that he seeks out or himself becomes the innovator. The interface between scientist and innovator should then be face to face. The most effective role for government to play in this relationship is to encourage this direct personal contact between the two and the worst thing it can do is to attempt to become the information broker, setting up bureaucratic agencies to play the role of intermediator.

The experience of Paprican is a very useful role model in this regard. By participating directly on campus in the training of graduate scientists and engineers it contributes directly to the creation of new knowledge. By carrying out sponsored research and development for, and in close consultation with the forest products industry, it is closely in touch with the current market needs and future opportunities. The interaction between scientist and innovator takes place naturally on a very frequent basis. Maintaining a good relationship between Paprican and the universities and between Paprican and the industry it serves requires continuous effort and takes a long time to develop. As a founding partner of Paprican the Government of Canada has provided encouragement and support without imposing itself

obtrusively at either the university or the industry interface. At the same time the industry has borne an increasing responsibility for the financial support and for the direction of the research effort.

The equipment manufacturers and process designers play an important role in the successful introduction of new technologies. This is an segment of our industrial base that has been neglected in recent years, at least so far as the forest products industries are concerned. The suppliers of this equipment to our industry today are largely offshore, or in other cases, subsidiary manufacturing facilities of companies which conduct their innovative engineering and development work at their foreign headquarters. Consideration should be given in a national policy to steps that will encourage such companies to carry out some of their development in Canada, since this would not only increase the viability of the Canadian subsidiaries but it would also facilitate their interaction with Canadian universities and other research centres. At present it is not unusual for the results of Canadian research to be picked up by equipment manufacturers in other countries and then imported back to Canada in the form of equipment for use in Canadian mills.

ROYAL SOCIETY OF CANADA

CANADIAN FORUM ON A NATIONAL SCIENCE AND TECHNOLOGY POLICY. A BRIEF TO THE MINISTER OF STATE FOR SCIENCE AND TECHNOLOGY BY THE ROYAL SOCIETY OF CANADA - ACADEMY OF SCIENCE.

PART I SUMMARY AND RECOMMENDATIONS

1 INTRODUCTION

The Royal Society of Canada, through its Academy of Science, appreciates this opportunity to participate in the Canadian Forum on a National Science and Technology Policy. The subject is vital to Canada and must receive continued meaningful attention by all concerned with the nation's future.

The Academy of Science is well qualified to speak for Canadian science. The Fellows of the Academy are drawn from across the physical, applied, biological and medical sciences and include in their number many of the most creative and productive scientists in Canada, as recognized by their peers. Through the other Academies of the Society they can draw upon a similar depth of knowledge in the Humanities and Social Sciences. In the past the Society has undertaken a number of studies that demonstrate the importance of scientific knowledge in deciding social issues. For example: the Society organized an appraisal of the environmental effects of a nuclear war with special reference to Canada (i.e. a nuclear winter scenario) involving technical studies and a public forum; in partnership with the U.S. National Research Council it arranged a study of the Great Lakes Water Quality Agreement and its implementation. (see appendix for a more complete list of examples). It stands ready to develop further investigations that will be needed to establish a long-term policy for science and technology in Canada.

The background paper for the Forum, "Building On Our Strengths", focuses on many of the relevant issues. The complexity of these issues, however, cannot be overestimated. They affect basic aspects of Canadian culture and national values. The Royal Society, therefore, sees this forum as the beginning of a long and potentially fruitful process requiring both practical courses of action and continuing analysis of the importance for Canada of the actions taken.

2 RECOMMENDATIONS

1. **Canada must continue to perform basic research** as its contribution to human knowledge and to its own culture. The level of funding for such research should be about the same percentage of GDP as the average for OECD countries. This would require expenditures of the order proposed in NSERC's Five Year Plan.

2. **Canadian universities should continue to have the main responsibility for basic research.** Improved benefits could come from a larger number of research positions to assist the most productive researchers, and from closer coupling of some research to industry. The latter should not result in diminution of basic research support, as many fear.

The erosion of individual research grants over the last decade by university charges for various services is a serious matter that requires urgent federal/provincial resolution.

3. **University/Industry cooperation should be encouraged by governments** through suitable incentives, while ensuring that returns are real. Cooperation occurs when there is perceived benefit on both sides. Governments should encourage this by suitable incentives while ensuring that returns are real. Administrative procedures should be simple and allow for long-term planning. Current proposals of matching grants may be in the right direction but conditions must be clarified.

4. **Industrial research must be greatly strengthened** if maximum benefits are to be derived from domestic and international advances in science and technology. Innovations require well-prepared soil to take root and flourish. Government research laboratories and institutes are playing a larger role in assisting industry. Mission projects, where the bulk of the work is done in industry with some government laboratory involvement, are also helpful.

5. **Improved S&T training in industry should be pursued as a key to utilization of the most advanced technologies.** Universities can assist through teaching, expansion of cooperative programs for both students and industrial organisations and consultation on technical developments. Governments need to encourage S&T development by assisting with the modernization of facilities, the provision of tax measures that would reward high-risk pre-venture capital expenditures and the transfer of information on production and marketing of new technologies.

6. **Government laboratories,** a successful Canadian solution to the problems of immense territory, dispersed population and a fragmented, foreign-dominated industry, **should remain an essential ingredient of Canadian S&T** by providing standards, mission-oriented research and essential services not otherwise available. Increasingly, cooperative programs with industry, of which good examples exist, will be the way of the future.

7. Adapability to change is seen as basically a matter of education, training and open consultation. Individuals need to be prepared for change in a climate of expectation rather than fear. To make informed political choices in technological matters a

greater degree of scientific culture and literacy is required by the population at large; **education in science should start at the earliest school levels.**

8. Technology tends to prosper in industrial concentrations and is generally at a disadvantage in isolation. Thus **efforts to use technology to improve regional balance should be assessed carefully on an individual basis.** Economic competition is always present; where economic considerations are favourable, integrated technology packages can be an attractive means of introducing technologically advanced industry into a region of Canada and into less developed parts of the world. The resulting development of technical skills would be an important byproduct.