

Q127
.C2
N243

c. 1 aa



CANADA

National Advisory Board
on Science and Technology

COMMITTEE ON
THE COMPETITIVENESS
OF THE RESOURCE



CANADA

Report of the
National Advisory Board
on Science and Technology

COMMITTEE ON THE COMPETITIVENESS OF THE RESOURCE INDUSTRIES

Presented to the
Prime Minister of Canada

INDUSTRY, SCIENCE AND
TECHNOLOGY CANADA
LIBRARY

JAN 25 1994

CAKY

BIBLIOTHÈQUE
INDUSTRIE, SCIENCES ET
TECHNOLOGIE CANADA



National Advisory Board on
Science and Technology

Conseil consultatif national
des sciences et de la technologie

The Right Honourable Brian Mulroney
Prime Minister of Canada
House of Commons
Room 309-S
Ottawa, Ontario
K1A 0A6

Dear Prime Minister:

I have the honour of transmitting on behalf of the National Advisory Board on Science and Technology, the Report of the Committee on the Competitiveness of the Resource Industries.

The topic which has been addressed by this committee is one of vital significance to Canada, concerning as it does the industrial sectors which for many years have been major contributors to our positive trade balance. In the opinion of the Board, with appropriate care and concern on the part of governments and industrial leaders, these industries will continue to be major wealth generators in Canada for many years to come.

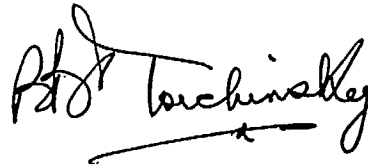
This report is the result of our investigations into the needs of the Canadian resource industries with a special focus on the mining and forestry sectors. It reviews the current status of these sectors, the importance of the effective use of advanced technology by the firms in these sectors to their wealth generation capacity, and the current programs and policies of the government which impact on their efforts to survive and compete in a very difficult market environment.

The Committee presents recommendations on how these industries should improve themselves, as well as recommendations to the government to ensure that the economic environment in Canada is as competitive as that of their competitors.

...2

The findings of the Committee, and the recommendations which we have derived from these findings, present challenges both to industry and to government. Each needs to improve its performance and its strategies to preserve and enhance these valuable cornerstones of our national economy.

Yours respectfully,

A handwritten signature in black ink, appearing to read "B. Torchinsky". The signature is stylized with a large initial "B" and a long horizontal stroke extending to the right.

Benjamin Torchinsky
Chairman
Committee on the Competitiveness
of the Resource Industries

The views expressed in this paper are those of the authors and do not necessarily correspond to the views or policies of the Government of Canada.

COMPETITIVENESS
IN THE
CANADIAN
MINING AND FORESTRY
INDUSTRIES

MEMBERS OF THE COMMITTEE

Mr. Benjamin B. Torchinsky Committee Chair
Chairman and CEO
AGRA Industries Limited

Dr. Brian L. Desbiens
President
Sir Sandford Fleming College of
Applied Arts and Technology

Mr. Guy G. Dufresne
President and CEO
Quebec-Cartier Mining Co.

Mr. Robert E. Hallbauer
President and CEO
Cominco Ltd.

Dr. Larry P. Milligan
Vice-President, Research
University of Guelph

Dr. Peter J. Nicholson
Senior Vice President and
Executive Assistant to the Chairman
The Bank of Nova Scotia

Mr. John A. Roth
President
Northern Telecom Wireless Systems

Secretariat:

Mr. Kenneth Beeson

Ms. Nancy Averill

Dr. William Coderre

TABLE OF CONTENTS

	Page
Executive Summary	i
Mandate of the Committee	iv
1. Introduction	1
2. The Canadian Resource Industries	5
2.1 Non-Ferrous Mining/Metals Sector	5
2.2 Forestry Sector	5
2.3 Perceptions and Realities about the Resource Industries	6
3. The Contribution of Technology to Resource Industries Competitiveness	8
4. Comparative Competitive Environment of Canadian Resource Industries	10
5. Analysis of the Issues	14
5.1 Sustaining and Expanding the Resource Base	14
5.2 Environmental Regulation	18
5.3 Value-Added or Forward Integration Strategies	22
5.4 Universities and Other Post Secondary Institutions	27
5.5 Government and Industrial Laboratories	28
5.6 Human Resources	29
5.7 Research and Development and Tax Incentives	33
6. Conclusion	37
APPENDIX A	List of Recommendations
APPENDIX B	Bibliography
APPENDIX C	Acknowledgements

COMPETITIVENESS IN CANADIAN MINING AND FORESTRY INDUSTRIES

EXECUTIVE SUMMARY

Concern has been expressed in recent years about Canada's dependence on natural resources. A lot of "propaganda" has been circulating which tells us that these are yesterday's industries; that the only future for Canada is in the knowledge based industries; that our resource industries will go, and should go, the way of the dinosaurs.

The NABST Committee on the Competitiveness of the Resource Industries has spent the past year and a half looking behind these perceptions and attitudes. We have found that the resources industries of Canada are still our strongest asset in the international marketplace, and are key to our country's capacity for wealth generation. However, unless we take action to reinforce these vital industries, we may lose the advantages they bring to our economy.

Canadian resource industries are strong assets

Canada's resource industries have been the mainstay of our prosperity for most of our history. They have pushed back the frontiers of Canadian settlement; they provide the export dollars which support our enviable standard of living and our social programs; and they provide Canadians with the only opportunity to live and work in many regions of the country.

They are the largest contributors to a positive trade balance (almost \$25 billion); they are responsible for 45% of total exports; they provide 16% of all jobs; and 465 communities in remote regions of Canada depend almost entirely upon them. Without the natural resources industries, the inhabited parts of Canada would be reduced to a narrow strip of land paralleling the U.S. border.

Resource industries are facing serious challenges

The traditional strength of our resource industries cannot be taken for granted. Today, these industries are in the midst of the most serious challenges they have ever faced. New and aggressive foreign competitors with lower supply and wage costs, increasing use of alternate materials, more rigorous customer demands, fast shifting trade patterns, and changing economic and fiscal environments are threatening the very survival of the Canadian resource sector.

Their ability to pull through will depend not only on the quality of their management but also on the fiscal and environmental policies of government which shape their economic climate.

We must face up to global competition

Other nations, in order to compensate for their lack of indigenous natural resources (Japan), or to compensate for higher cost feedstock (the Scandinavian countries), invested more heavily than Canada in research and development and in those downstream products and industries which rely more on intellectual than natural resources.

Canada fell behind these countries during the past decade because our natural advantages of bountiful resources and relatively cheap energy supported us with relatively minor effort. But all this changed by the end of the 1980s and we have had to face up to the realities of the global marketplace.

The resource industries are still in the fight

As in the case of Japan and the Scandinavian countries, Canada also has the ability to create new opportunities based upon the creativity and innovative spirit of our researchers, workers and managers. In its studies, and consultations the Committee found that many Canadian resource companies are already highly sophisticated and technically-advanced enterprises. They develop, adapt and apply advanced technologies in disciplines as varied as robotics and biochemistry to assist their operations. But many problems still exist and must be addressed if this major world-class industry is to retain its prominent position.

Environmental regulation must be better organized

The industry recognizes that environmental regulation is necessary and desirable, but much more needs to be done to make regulations and their application more efficient. In the Committee's view, unwarranted delays and inconsistencies caused by jurisdictional confusion must be eliminated.

For example, the process for acquiring permits to establish new mines can take as long as two years. The applicant has no way of knowing at the onset of the approval process what the regulations will be, the amount of time that the process will take or what it will ultimately cost. There are known promising deposits in Canada today which await development but are idle because of such delays and uncertainties in the environmental regulatory processes.

We urgently ask the federal and provincial governments to untangle the confusion of overlapping responsibilities and to increase the transparency of environmental regulations. We also ask that these regulations be well founded on scientific reality, and that economic factors be given full consideration in their application.

Adding value to basic resources

Many Canadian resource companies have already found success in adding value to their raw materials. For example, Canadian forest product R&D in this area has won Sweden's prestigious Marcus Wallenberg Prize three times since it was first awarded in 1981. One of these winners was the development of the Parallam process by MacMillan Bloedel, which takes strands of unusable wood to create a beam with better properties than the original tree.

Canadian mining companies are also actively involved in adding value through specialty materials for batteries and for semiconductors, and are pioneering the use of bio-technological processes for mining. While stronger efforts to develop value-added production for the Canadian

resource industry must be encouraged, we must recognize that forward integration alone is no panacea to the basic industry which must be strong itself before it can reach out into other areas.

The need for qualified people and coordinated, relevant R&D is critical

Above and beyond all that we have reported about the resource industries and their need to cope with the new realities of the global marketplace, we must also ensure that they will have access to the qualified people they need: men and women at the leading edge of research and those with appropriate training and technical skills.

Research labs are a needed resource

The universities and colleges of Canada must rationalize their research programs so that we can have world class expertise focused on the most important challenges to the industry, rather than a "smorgasbord" of secondary programs. Closer liaison with industry executives in developing their research programs would help to accomplish this.

Government laboratories must be even more responsive to the needs of industry, especially in areas such as forest management, exploration technology and downstream added-value product development.

Education and training are key factors

We need better basic educational standards in our schools, and tough evaluations of their effectiveness in producing well-educated students. We also need more effective and widely-used apprenticeship programs to develop a skilled labour force. A national program for encouraging training such as the Employee Training Loan Scheme proposed by the Economic Council would help address this need. Also, national standards for apprentices would remove mobility restrictions for workers and allow them to move more easily to where jobs are to be found.

The industry, the government and the educational sector all need to provide a counterbalance to the propaganda that leads our brightest and best young people to turn away from, and even against, the idea of working in resource-based industries.

Our future depends on a healthy resource sector

The challenge for all of Canada, not just its resource industries, is to obtain a healthy balance in the development of all of our resources, both natural and intellectual. The members of the Committee believe that we can build upon the traditional economic strength of our natural resources while adding to it the power of downstream development and the dynamism of the new "knowledge industries" of the service sector. Our future depends on it!

MANDATE OF THE COMMITTEE

In September 1991, the National Advisory Board on Science and Technology identified the Canadian Resource Industries as important segments of the economy meriting particular study. The Board assigned the Committee on the Competitiveness of the Resource Industries to analyze and report on the role that science and technology plays, or could play, in improving the competitiveness of Canada's resource industries. The Committee limited its review to the forestry and non-ferrous mining/minerals sectors in order to control the size and scope of the study and to enable it to concentrate on specific companies and their perspectives on research, science and technology.

The companies involved in the study were selected on the basis of their industry leadership and their record in innovation. The study was tightly focused to enable the Committee to develop ideas and practical suggestions on how companies in those industries and related industries could use science and technology to greater advantage. The committee in particular considered:

- how science and technology (S&T) has contributed to efficiency and productivity improvements,
- how S&T enabled Canadian companies to have a wider choice of business strategy options, including value-added processing and innovative production techniques, and
- what policy prescriptions could be recommended to government and others to strengthen the industry.

A successful competitiveness strategy demands coordinated action on the part of government, industry (business and labour) and universities. This report recommends a science and technology strategy based upon a variety of perspectives which include joint action, industry action and public policy.

*"Global competitiveness depends on three elements: company competitiveness - ability to design, produce and/or market products superior to those offered by competitors...; sector competitiveness - the extent to which a business sector offers potential for growth and attractive return on investment; country competitiveness - the extent to which a national environment is conducive or detrimental to business."*¹

New Compacts for Canadian
Competitiveness

Joseph D'Cruz and Alan Rugman,
University of Toronto, March, 1992

1. INTRODUCTION

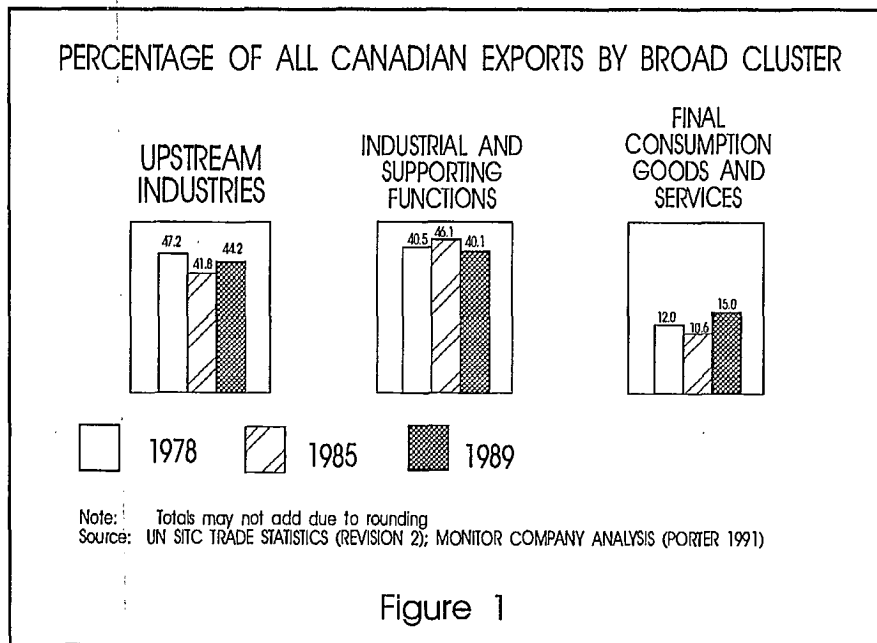
Canada's resource industries have been the mainstay of our prosperity for most of our history. They have pushed back the frontiers of Canadian settlement; they support our enviable standard of living and our social programs; they provide Canadians with the only opportunity to live and work in many regions of the country; and they have contributed significantly to the development of our sophisticated telecommunications and transportation systems.

It is easy for urban Canadians to forget this long-standing source of our wealth and comparative advantage. Unprocessed and semi-processed resources represent approximately a third of all of Canadian exports, and processed resources provide a further 10%. Resource industries create one job of every six. Furthermore, resource-based exports are almost the only part of our extensive foreign trade which contributes to a positive trade balance² (Figures 1-3).

Natural resources represent one of Canada's strongest strategic advantages in international competition. Our future prosperity depends as much upon our continuing ability to discover and exploit our natural resources as it is coming to rely on our knowledge-based manufacturing and service sectors. This traditional strength cannot be taken for granted.

Today, Canada's resource industries are in the midst of the most serious challenges they have ever faced. New and aggressive foreign competitors with lower supply and wage costs, increasing use of alternate materials, more rigorous customer demands, fast shifting trade patterns, and changing economic and fiscal environments are all testing the mettle of Canadian resource company managers.

Science and technology focused on assisting in the exploration, development and application of our natural resources will play a key role in building a successful future for Canada's resource industries. However, science and technology alone will not be enough: the investment climate,



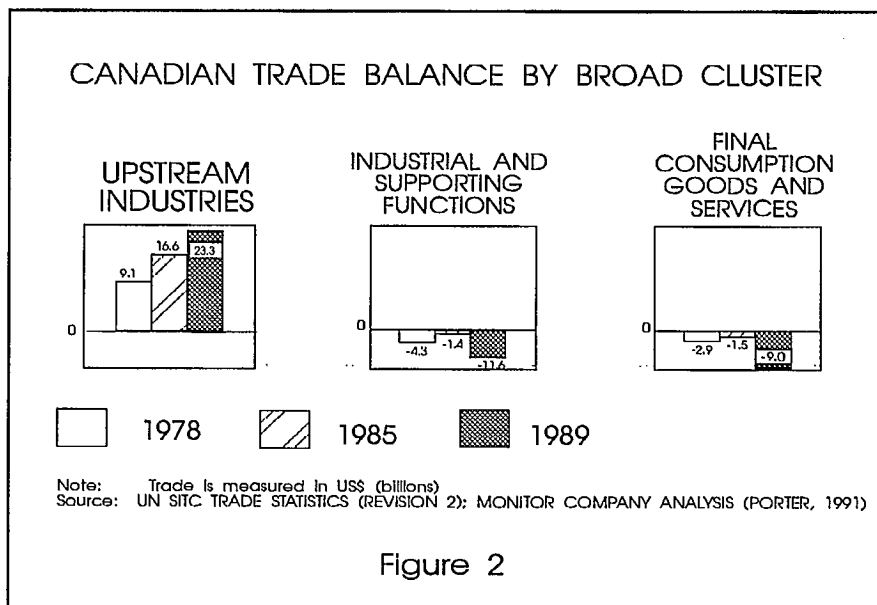
environmental and regulatory policies, and the quality and training of personnel are also significant in the re-establishment of a vigorous and viable resource sector in Canada.

In preparing this report, the Committee on the Competitiveness of the Resource Industries sought out the views of the chief executives and senior managers of some of the largest forestry and mining corporations in Canada as well as those that are most innovative. Key questions were posed and discussed both in intensive group sessions and in "one on one" meetings. We also held dialogues with senior managers within the federal government.

We found many Canadian resource companies to be sophisticated and technically-advanced enterprises. They develop, adapt and apply advanced technologies in disciplines as varied as robotics and biochemistry to assist their operations. We identified and studied corporations which are adapting to competitive challenges. Although each corporation has a unique strategy, those who are successful have integrated S&T into all facets of corporate decision making.

Canadian resource firms are facing strong and growing competition from firms in other parts of the world who now enjoy their own special advantages such as richer ore bodies, faster growing timber stands, and co-operative governments anxious to attract private investment for the development of their own countries.

We found, in Canada, an industry sector whose competitiveness depends as much on the economic and regulatory environment as it does on productivity. Not only are Canadian resource-based companies in competition with other resource companies throughout the world; the Canadian government is also in competition with the governments of other countries who are creating an attractive investment climate for both domestic and foreign based companies. These governments use investment, environmental and incentive policies to encourage investors to explore, exploit and export local resources. The situation is not unlike that of the aerospace industry, where government policies and direct support attempt to tilt the playing field to the advantage of their companies. Without such a positive investment environment, Canadian resource companies are disadvantaged in world markets.



Industry leaders expressed strong and frequent concern about the major impact that the relative value of the Canadian dollar has on their ability to export at competitive prices. They reported that this one factor alone was the cause of an approximately 20% disadvantage. At the time of these interviews the dollar had been hovering between 83 and 88 cents U.S. during the previous year. While we have taken serious note of this concern, the committee focused its attention primarily on the factors closer to its mandate, namely those aspects of competitiveness related to science and technology.

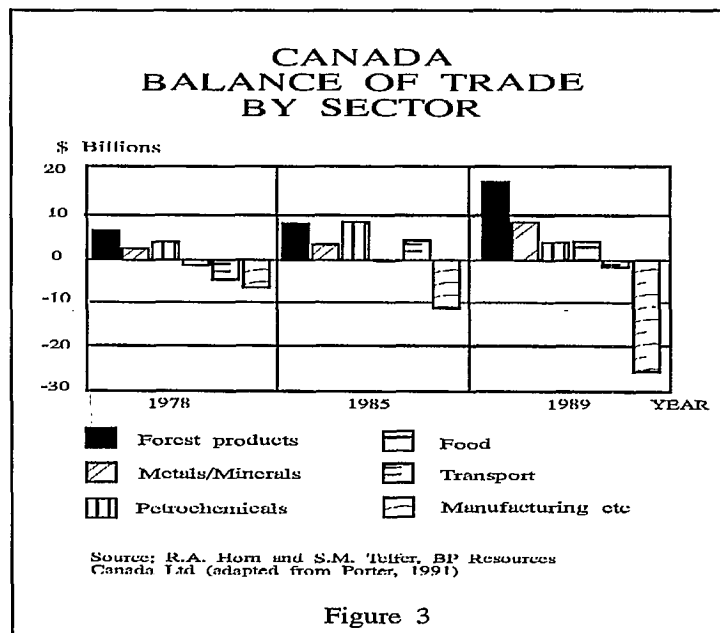
Our study identified seven key areas related to science and technology which have or could have a pronounced impact on the competitiveness of the Canadian resource industries sector. We then developed a series of recommendations pertaining to these areas which we believe will assist the resource industries in their serious quest for improved competitiveness. The seven areas are:

1. Sustaining and expanding the resource base;
2. Environmental regulation;
3. Value-added or forward integration strategies;
4. Universities and other post secondary educational institutions;

5. Government and industrial laboratories;
6. Human resources;
7. Research and development and tax incentives.

We limited our recommendations to those which we believe have the highest priority and which could be implemented almost immediately by government, industry (management and labour) and the education community working in concert in the best interests of the Canadian economy.

Canada's growing manufacturing and services sectors are dependent on the social services and national infrastructure which, in a very real way, are paid for with the net positive trade balance that the resource sector provides. Consequently, any weakening of the industries within the resource sector must be considered a crisis whose resolution must be one of the highest priorities of the government. While there is no question that the major responsibility to help Canada's resource sector meet the global challenge resides with management, government must provide a supportive environment to help management do the job. We believe our recommendations, presented in section 5 and listed for convenience in Appendix A, will assist in the resolution of this crisis. The future prosperity of Canada is at stake!



A VANISHING SPECIES?

PERCEPTION:

Resource Industries are sunseting and are no longer important to the Canadian economy.

REALITY:

Canada's traditional economic reliance on its natural resources is well recognized and widely-known. Our ability to rely equally in the future on these resources is not quite so clear. As the availability of natural resources diminishes and as national economies evolve there is a tendency to shift from exporting primary products to manufacturing and purchasing raw materials from abroad. The pressure to follow this pattern hinges on an underlying sense that basic mining and forestry are hold-overs from the past and that a higher status may be achieved in a country that earns its foreign exchange on what it knows rather than on what it has.

To belie this misconception, the Financial Times lists 30 resource related companies in its 1992 list of the 100 top growth companies in Canada. Directly, the resource industries contribute 16% of all employment in Canada. These are important jobs because of their high value-added content (as a ratio of job cost to sales), and because of their contribution to regional development. In all regions of Canada, 350 communities are solely dependent on the forest sector and 115 communities on the mining sector. Without these industries, "Canada" would be not much more than a thin band along the U.S. border.

The resource industries are also the origin and stable base of a very successful and internationally competitive engineering consulting and exploration community which has grown twenty-fold since 1975. Canada is the fourth largest trader in international consulting engineering contracts after the U.S., the U.K. and the Netherlands; many of these contracts relate to resource industry expertise. Resource industries are also a major contributor to the transportation industry in Canada.

Our resource industries are the backbone sector of the economy. They are by far our major source of trade surplus and constitute the core of Canada's overall prosperity. The new competitiveness challenge of globalization means, however, that the industries themselves and public policies supporting them must be redirected to meet this challenge. Our economic future is very much dependent on our ability to do so, and science and technology are important tools which can help contribute to this strategy.

2. THE CANADIAN RESOURCE INDUSTRIES

2.1 NON-FERROUS MINING/METALS SECTOR

In 1991, the four stages of ferrous as well as non-ferrous mining activity (mining and concentrating, smelting and refining, semi-fabrication of minerals and metals, and metal fabrication) contributed a total of \$22.8 billion to the Canadian economy and accounted for 17% of total export revenues. The value of 1990 mineral production per capita in Canada was \$680 compared to only \$50 in the U.S.A.³ Canada leads the world in the value of mineral exports and ranks fourth among the diversified minerals producers in non-fuel mineral production, behind the former Soviet Union, the United States and South Africa⁴.

Ownership in the Canadian mining sector is concentrated in a few major firms. In 1989, eight mining companies [INCO, Falconbridge, Cominco, Noranda, Placer Dome, Brunswick Mining and Smelting, QIT Fer et Titane Inc. and Iron Ore Company of Canada] accounted for nearly 60% of the total revenue of all the non-fuel, mineral mining companies in Canada. Some firms are fully integrated in that they are active in mining, smelting and refining. These include INCO, Falconbridge, Cominco, and Noranda. Others concentrate on a particular aspect of the industry. For example, Rio Algom and Placer Dome are primarily mining corporations. On the other hand, Alcan and Sherritt Gordon have no mines in Canada; their operations include smelting, semi-fabrication and the development of new products.

The major firms are complemented by many "junior" mining companies. "Juniors" are exploration companies usually without ore deposits of their own. They are generally involved in exploration, holding or trading of potential mineral properties and in mine

development. Once they have income from mineral/mining production, they cease by definition to be juniors. Most of Canada's major companies have grown from the ranks of juniors and many of Canada's most important ore bodies are the result of exploration successes by junior companies. The Louvicourt polymetallic sulphide deposit was discovered by a junior company, Aur Resources, at Val-d'Or, Quebec in the late 1980's. This deposit is the most important discovery in Eastern Canada since Kidd Creek was discovered in the 1960's. Previously, the Hemlo gold deposits were discovered by Corona Resources, and there are many other examples of important discoveries by junior companies, both in Canada and elsewhere in the world, as even junior companies have spread their wings to explore in the U.S., Mexico, Australia and South America. The junior mining company is uniquely Canadian and has been a major factor in developing the Canadian mining industry. For this reason, government policies must recognize the importance of this segment of the industry when considering the future of mining in Canada.

2.2 FORESTRY SECTOR

The forestry industry is a major economic force in all regions of the country. It represents 45% of manufacturing in B.C., 21% in Atlantic Canada, 15% in Quebec, 6% in Ontario and 9% in the Prairies. In 1991, 300,000 Canadians were employed directly and an additional 500,000 indirectly, in the industry.

The sector can be divided into two industry groups:

2.2.1 Paper and Allied Industries:

- i) pulp and paper: market pulp, newsprint, fine papers and paperboard
- ii) converted or value-added paper products: packaging, fine papers, tissue and other consumer paper products

The newsprint and paper sector comprises 43 mills owned by 21 companies, with an annual productive capacity of more than eleven million tonnes. This represents about one-third of total world production. About 88 percent of that capacity is employed in the production of newsprint and the remainder is for specialty paper.

2.2.2 Wood Industries:

- i) commodity products: lumber, plywood shingles and shakes, veneer, particleboard, oriented strandboard, waferboard
- ii) value-added wood products: manufactured housing, doors, windows, kitchen cabinets, hardwood flooring, pallets and millwork

Canada is the world's largest exporter of softwood lumber, with some 50% of international trade and 15% of world production. Ninety-five percent of production comes from approximately 225 major companies which operate about 365 sawmills, with 25 large integrated forest companies accounting for fifty percent of production. Most of these firms are Canadian-owned (about 20% of production is by foreign owned firms).

In 1990, the total of all forest products sector shipments was \$38 billion. Exports amounted to \$22 billion, while imports were \$3 billion, providing a trade surplus of \$19 billion (15.5 %

of Canada's total net trade). During the 1980's, the sector contributed between 2.6 and 2.8 percent of Canada's GDP, and accounted for 13 to 15% of total manufacturing activity and 14 to 17% of total exports.

In 1991, the forest product industry shipped \$35 billion of products; exports totalled \$20 billion and the industry contributed \$17.5 billion to Canada's balance of trade.

After achieving record profits in the late 1980's, the industry reported a record loss of \$2.5-billion in 1991. (During the previous recession, industry losses were \$265-million.) Industry mills operated at 94% capacity in 1989, 88% in 1990 and 85% in 1991.

2.3 PERCEPTIONS AND REALITIES ABOUT THE RESOURCE INDUSTRIES

The study for the preparation of this report uncovered many widely held perceptions and even misconceptions about the Canadian resource industry sector. The senior executives who generously gave of their time in helping the committee to investigate the factors of competitiveness in this sector held very strong feelings on these matters. In boxes distributed throughout this report, we have included discussions of some of these commonly held perceptions and the facts as we found them.

MERE HEWERS AND DIGGERS?

PERCEPTION:

Resource Industries are technologically backward: mere "hewers of wood and diggers of ore".

REALITY:

In June 1990, a report was published jointly by Industry, Science and Technology Canada (ISTC), CANMET, Communications Canada and Statistics Canada on the level of technology diffusion in the Canadian mining industry²⁸. The report observed that *"235 Canadian mines are riding the wave of technological change, of which two thirds have seen positive improvements in productivity, more than half have realized improved product quality, and two-thirds have experienced a reduction in costs."* The report analyzed the extent of application of some 28 specified advanced technologies in four major categories: automated materials handling; communications and networks; control; and automated processing systems. More than half of the mines, representing 85% of total mining employment, were reported to be using at least five of the 28 advanced technologies.

The technologies most often found in use were programmable logic controllers, automatic bin level measurement, flow density measurement and analog controllers. Significant growth was indicated in the use of underground data communication networks, supervisory control and data acquisition, integrated expert systems for process control, and on-line statistical process control. Larger mines, both Canadian and foreign owned, were the most extensive users of advanced technologies.

The overall level of effective technology employment in the mining industry was found to be very high. This increasing sophistication of Canadian mining has made it possible for companies to continue to compete despite declining ore quality and higher transportation and access costs as compared to many of their competitors.

Some forestry and pulp and paper companies employ extremely sophisticated and up-to-date technology in the field and in their mills and papermaking plants. Modern thermomechanical (TMP) and chemi-thermomechanical (CTMP) pulping technologies, which rely on higher energy input but are much more efficient in the use of fibre, are employed effectively in many Canadian plants. These newer techniques reduce contaminated effluents and allow for increased use of sawmill wastes instead of roundwood as source materials.

Canadians have led the world in the use of high speed processing of small diameter logs to increase labour productivity, and currently sawmills are developing techniques for maximizing product value and optimizing product yield.

Canadians are at the leading edge of the application of biotechnology in mining and in the development of trees with higher yields and quality, faster growth and disease resistance. Canadians are also world leaders in forest fire and pest protection technologies.

3. THE CONTRIBUTION OF TECHNOLOGY TO RESOURCE INDUSTRIES COMPETITIVENESS

The development of innovative technology and the effective acquisition and adoption of foreign technology has characterized the Canadian resource industry sectors for most of their existence [see box on page 7].

A study of the Canadian mining sector features numerous examples of the successful application of innovative technology. INCO Limited developed a new vertical retreat bulk mining methodology which gave it dramatic improvements in productivity. Ongoing cooperative research into rockbursts led by the Canada Centre for Mineral and Energy Technology (CANMET) of the Department of Energy, Mines and Resources (EMR) and involving the Ontario universities, mining companies and the provincial government has led to changes in mining practices which eliminate costly and dangerous problems in mines. Another area where technology is finding increasing application is in the use of sensors. Sophisticated sensors monitor equipment and mine parameters and feed these into computer-based data-acquisition systems to provide real-time analysis and control of mine operations.

Canadian mining companies have been at the forefront of technological advancements. For example, continuous mining and new cutting techniques are at the leading edge of mining technology and hold forth the promise of transforming the nature of mining. Biotechnology (bio-leaching) is already being applied by Rio-Algom and Cominco in new mines under development in Chile. It is also being used to

address some environmental problems. New techniques for remote guidance are being applied for moving machinery and for drilling operations, and mine operations software developed in Canada is finding a world wide market.

Smelting and refining technology has also been developed and improved by Canadian companies over the years. Sherritt Gordon's high pressure hydrometallurgical technology has been exported around the world. Falconbridge has developed a technique for extracting indium from its Kidd Creek copper and zinc mine tailings. They estimate that they can win a 30% market share of this important new material used in optoelectronic devices and solid state lasers for fibre optic communications systems.

Canadian exploration firms associated with the mining and mineral resources sector have also been at the forefront of technical developments in surveying, mapping and detection of ore bodies. These services, developed and perfected first in Canada, have been and are being exported to many different countries all over the world. The Geological Surveys Branch of EMR has played a significant role in such developments and continues to provide leadership in developing new ideas and technologies to help industry to enhance Canada's base metal reserves.

Canadian forest product R&D has won Sweden's prestigious Marcus Wallenberg Prize three times since it was first awarded in 1981^a. One of these winners was the development of the Parallam process by MacMillan Bloedel. In this process, wood fibre is extruded with a binding agent to produce beams or billets of wood-like material, but which are stronger than the original wood, for construction applications. This creates valuable wood products out of less valuable source material. Other new generation

^a 1981: Harry Hutchinson of Mississauga for research into wood pulping processes; 1982: Ricardo O. Foschi of Vancouver for research into the development of mathematical models to illustrate and test the mechanical performance of wood structures; 1987: MacMillan Bloedel for the development of Parallam.

reconstituted and composite wood products such as MDF-faced strandboard help Canadian companies compete with alternate materials.

Canadian sawmills have led the world in the use of technologies to maximize the value output of lumber from smaller logs and in the reduction of saw-kerf losses. The application of advanced biotechnology to forestry in Canada is leading to the development of "supertrees": disease resistant, high quality trees which grow well in the Canadian environment. A recent initiative has been announced to create model forests to advance understanding of ecosystems management. Yet, despite all of the developments and progress made in Canadian forestry technology, much of the equipment used in the industry is not made in Canada; approximately half of harvesting and sawmill machinery is imported.

The pulp and paper industry in Canada has a proud record of technological achievement. A Canadian papermaking technology (the twin-wire paper machine) has proved to be an industry standard; unfortunately this technology is now the property of Valmet, a Finnish firm. New pulping technologies taking advantage of Canada's relatively abundant hydropower (Thermomechanical Pulping (TMP) and Chemi-thermomechanical Pulping (CTMP)) have improved yield, broadened the available feedstock to include hardwoods, increased the use of sawmill wastes in Canadian pulp mills and have reduced the amount and toxicity of effluent waste water. One company has opened a modern CTMP plant using aspen trees in northern Alberta; it is so efficient in its use of water that it does not need a water discharge permit. A large number of papermills however, are still based upon older facilities, particularly in eastern Canada, and the bulk of paper mill technology is imported.

A recent breakthrough by Repap, the ALCELL process, based on a unique ethanol and water extractor operating at high temperature and

pressure, holds forth great promise. The process eliminates air pollutants such as sulphur dioxide and hydrogen sulphide as well as chlorinated organics and dioxin. The utilization of wood fibre with this process can be as high as 90%, as compared to the typical 50% of other processes. The pure, sulphur-free lignin which is a by-product has its own market as a waterproofing agent in packaging materials which can be recycled (unlike plastic or wax), and in automobile brakes, rubber tires and leather goods.

In spite of the excellent and successful utilization of science and technology for its requirements in the past, the Canadian resource industries must not rest on their laurels. In this age of knowledge-based global competition, all industries must invest aggressively in new technologies to improve their processes in order to remain world competitive. The current low levels of R&D spending by Canadian resource companies is worrisome when contrasted with the efforts being expended by their competitors.

Firms are challenged with creating new processes which are inherently less harmful to the environment. They are trying to adapt current processes to eliminate harmful by-products and to develop techniques for dealing with existing toxic wastes while at the same time reducing production costs. Addressing these major concerns is difficult for an industry which is already under extreme competitive pressure.

Technological solutions must be found. The Canadian resource industries have in the past had an excellent track record in technical development and adaptation. Many government and university laboratories have researchers with considerable relevant expertise. Governments at all levels, together with universities and colleges and the firms of the resource sector must work collaboratively with respectable amounts of funding if these technical challenges are to be met.

4. COMPARATIVE COMPETITIVE ENVIRONMENT OF THE CANADIAN RESOURCE INDUSTRIES

Canada's non-ferrous metals sector is among the largest in the world. Our competitive advantage has been based on an abundance of mineral deposits, relatively inexpensive electrical power, excellent technology, a skilled work force, and proximity and access to markets - primarily the U.S. Our relative disadvantages are climate, lack of infrastructure and the high cost of providing it (such as transportation and communications systems in the far north where most natural resources are to be found), long transportation routes to tidewater, high labour costs, and a higher marginal tax rate.

The forestry industry in Canada is under extreme competitive pressure from other regions whose climate permits faster growth of wood fibre and where silviculture practices and woodlot management have been in place for long periods of time. Beyond the problems created by a high Canadian dollar, the Canadian pulp and paper industry is estimated to be at a 20% cost disadvantage relative to its U.S. competitors (Figure 4)⁵; because of relatively lower tax incentives, higher interest rates, higher labour costs, higher transportation costs and lower overall productivity levels. As well, a large number of Canadian pulp mills are old, of sub-optimal size, and expensive to upgrade; hence they are less productive than more modern mills.

Other competitive factors influencing Canadian forestry companies are the climatic conditions they face in accessing timber sources in Canada, the uncertainty surrounding the application of new environmental standards and growing restrictions on land use and access resulting from aboriginal land claims and the trend toward environmental preservation.

Canadian plants have for a long time capitalized on the relative availability of low-cost hydroelectricity or the ability to generate their own power. These advantages are being weakened by higher energy prices and the lack of an appropriate co-generation policy. In contrast to this, energy co-generation systems in Finland now help the industry to be net energy suppliers.

Scandinavian pulp and paper companies in particular have become more competitive through a major restructuring of the industry to eliminate inefficient plants and invest in newer plants, especially those producing high quality, high valued paper. Between the mid-1970s and the mid-1980s the combination of the energy crisis, the environmental movement, and the opportunities afforded by free trade in Europe led governments and industry to cooperate in a process which resulted in a 50% reduction in the total number of firms. Mergers and amalgamations were encouraged, thus eliminating marginal operations. Tax incentives supported and provided needed funds for recapitalization and the liability for severance pay and employee retraining or relocation was borne by governments.

During the same period, until 1984, the Canadian government provided incentives to keep plants running (and the local towns viable) through modernization, upgrading and extensions to old mills. Still today 40% of the equipment in Canadian mills was first installed prior to 1930. With the inherent advantages of lower cost feedstock and cheaper electricity the industry was able to compete; however, with the benefit of hindsight we can see that the Scandinavians chose a better strategy for the long term strength of their pulp and paper industries.

In recent years the investment climate in many resource-exporting developing countries has changed as a result of major revisions to their laws which are aimed at attracting investment to

COMPARISON OF FORESTRY COSTS DIFFERENCES

- There are some fundamental differences in costs among the regions

1990 Delivered Cost - Canadian Dollars per Tonne¹

	U.S. South	U.S. West	Eastern Canada	B.C. Interior	Sweden	Finland	B.C. Coast
Wood fibre	\$ 138	\$ 204	\$ 260	\$ 201	\$ 403	\$ 460	\$ 222
Chemicals	79	56	64	61	54	63	61
Energy	24	39	31	37	14	9	59
Labour	70	72	90	101	102	64	148
Other mill level	62	80	73	147	58	47	138
Total mill level	373	451	518	547	631	643	628
Corporate and selling	14	17	26	9	17	16	37
Delivery	68	69	64	97	60	57	70
Total delivered	<u>\$ 455</u>	<u>\$ 537</u>	<u>\$ 608</u>	<u>\$ 653</u>	<u>\$ 708</u>	<u>\$ 716</u>	<u>\$ 735</u>
Total delivered (in U.S. dollars)	<u>\$ 390</u>	<u>\$ 460</u>	<u>\$ 521</u>	<u>\$ 560</u>	<u>\$ 607</u>	<u>\$ 614</u>	<u>\$ 630</u>
Capacity utilization rate							
1990	97%	98%	81%	89%	89%	82%	64%
1989	98%	99%	92%	91%	95%	91%	91%

(1) Before depreciation

- The Finnish pulpmills are very labour-efficient and their high output per man hour is reflected in the low labour cost per tonne (despite an 82% capacity utilization rate in 1990). Canadian and Swedish labour costs are comparatively high, particularly the B.C. Coast.
- The U.S. South has an important fibre cost advantage over all the other regions - only about one-third the Finnish fibre cost, for example.

Figure 4

have been liberalized to reduce or eliminate former restrictions on foreign ownership. Some governments have also reduced taxes on foreign investments in the local economy. Foreign currency exchange restrictions have been relaxed, debt-equity swap programs have been created, and formerly nationalized industries have been privatized in the effort to encourage foreign investment. Mining investment in some developing countries has been encouraged by opening up for exploration formerly restricted lands, by revising and simplifying mining laws, and by reducing import tariffs, freight rates, export duties and price controls.

According to The Canadian Mineral Industry in a Competitive World⁶, the Report of the Intergovernmental Working Group on the Mineral

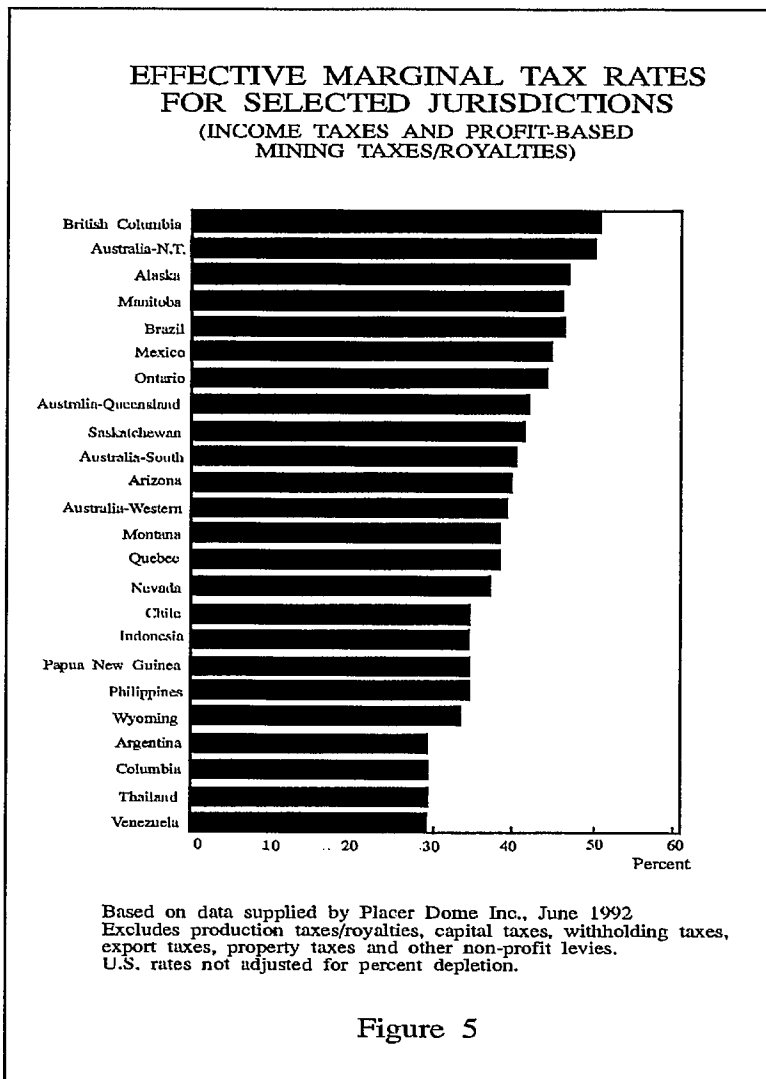
Industry (IGWGMI), September 1992, the effective tax rate for Canadian mineral companies has become less competitive over the past few years. In 1985 the effective marginal tax rate in Canada was generally more favourable than that in such countries as Chile, Mexico, South Africa, Brazil, Australia and the U.S. In 1992 however, Canada's tax provisions have gone from favourable to among the least favourable (see Fig. 5). Within provincial jurisdictions, only Quebec has resisted this decline in the competitiveness of the investment climate.

A number of other tax rules were reported by the IGWGMI as having an impact on the attractiveness of Canada for mineral investments: the tax treatment of payments into mine reclamation funds; capital cost allowances; the

reclamation funds; capital cost allowances; the inclusion of intangible exploration and development costs in calculating tax. The IGWGMI Report recommends that these issues are worthy of more study and vigilance on the part of both levels of government.

Although it recognizes that tax and economic policies are not the only factors which influence the level of investment in the resources sector, the Committee is concerned about the competitive investment climate within which the resource industries are operating and calls upon the government to sustain an attractive economic

climate for these important Canadian industries. A much smaller sector in terms of contribution to Canada's GDP and exports, the aerospace sector, appears to receive special treatment from the government to compensate for the advantages afforded by the national governments of its competitors. Yet, the contribution of the resource industries to the Canadian economy is much greater than that of the aerospace group. The committee is calling for immediate action to provide a more level playing field for the Canadian resource industries as they compete on a global basis.



ARE WE RUNNING OUT OF RESOURCES?

PERCEPTION:

Our resource industries are dying because we are running out of natural resources.

REALITY:

While it is true that Canadian mining companies are exploiting ore bodies with much lower mineral content than many of their competitors, this has been compensated for, at least to some extent, by the introduction of highly efficient and technically sophisticated extraction and processing technologies.

It is also true that easily mined surface ores are becoming harder to find in Canada, but industry leaders point out that this is analogous to the situation when shallow oil wells were depleted. The answer for the mining industry, as it was for the petroleum industry, is to develop the exploration and extraction technologies which can locate and exploit deeper reserves of which Canada has acknowledged great potential.

Exploration expenditures have fallen in Canada from approximately \$1.5 billion in 1988 to less than \$500 million in 1992 (Fig.7). Changes in incentive policies in Canada have exacerbated this trend. Nonetheless there are known promising deposits in Canada (copper at Windy Craggy, B.C., and uranium at Cigar Lake, Saskatchewan) which await development but are idle because of environmental factors among others concerns.

Canadian forestry companies are forced to go further from established transportation facilities to harvest timber, and the pressures to preserve forest lands for heritage, recreational and aboriginal peoples' use has reduced the availability of forests somewhat. The rate of re-growth of trees is slower than for southern forests and reforestation in Canada has lagged behind that in other countries where managed woodlots and tree plantations are already supplying significant percentages of their requirements. On the other hand, mature and over-mature forests still account for 52% of our productive forest land. Current silviculture programs are developing new strains of trees which will grow well in Canada and the forest management techniques to maximize their productivity are also available, so there is little immediate danger of running out of forests to harvest.

Public interest in the environment and new regulatory policies in the U.S. and Canada are changing the economics and dynamics of papermaking. Companies in the U.S. are being forced to increase the amount of recycled paper in their production in an effort to save trees and reduce the volume of materials going into landfill sites. This has a powerful effect on Canadian papermakers who export a very large amount of newsprint to the U.S. The sources of new fibre for newsprint are found in increasingly remote regions of Canada, with concomitant transportation costs, while the sources of recyclable newspapers are in the major urban centres of the U.S. and Canada. Compulsory use of 40% recycled fibre means either shipping new pulp to plants near urban centres or shipping old newspapers to remote papermills. Neither scenario is economically attractive. According to one industry executive, for Canadian papermills to meet a 40% recycled target, 4.5 megatonnes of newspapers would have to be imported into Canada every year, and the processing costs would increase by \$150 per tonne. The answer for many firms would be to establish plants for 100% recycled materials near urban centres. However, this is not entirely practical since some new fibre content is always required to make good quality recycled paper.

5. ANALYSIS OF THE ISSUES

The Committee identified seven key areas where either coordinated action on the part of governments and industry or adjustments to public policy could contribute to the competitive advantage of the industry. These are:

1. Sustaining and expanding the resource base;
2. Environmental regulation;
3. Value-added or forward integration strategies;
4. Universities and other post secondary educational institutions;
5. Government and industrial laboratories;
6. Human resources; and
7. Research and development and tax incentives.

5.1 SUSTAINING AND EXPANDING THE RESOURCE BASE

Building on the past; growing for the future

5.1.1 Exploration: the essential mineral research activity

The mining industry argues that its top priority is the discovery of new ore bodies because its future as an industry is at stake. Mineral reserves are in a decline and projected mine closures over the next few years will place the industry in a critical position. The decline of the inventory of mineable base-metal ores has sharply diminished the time available for finding and developing new ore to sustain Canadian mine production through the 1990's at current levels. Unless substantial new discoveries of copper, zinc and lead are made in Canada beginning almost immediately, there will be a progressive decline in Canadian output of these metals beginning by the mid-1990's⁷ (Fig.6). For this reason, the mining and mineral industry spends, on average, 2.6% of sales on exploration compared to only 0.9% on R&D⁸. While this is not "research" as defined by Revenue Canada, it represents a considerable necessary expenditure for the survival of the industry, equivalent in importance

and in risk to the new product R&D carried out by manufacturers such as the development of new drugs by the pharmaceutical industry [see box on page 13].

During the period 1983 to 1989, a "Flow-Through Share" scheme provided a tax incentive to encourage investment in mining companies. The "flow-through" share purchasers were able to enjoy immediate tax write-offs resulting from the use of their investment by the mining company to pay for new exploration activity. This tax shelter plan encouraged many people to invest in companies exploring for new ore deposits, particularly gold companies⁹(Fig. 7). In 1989 this incentive was revoked in a tax reform effort designed to create fair and equitable tax treatment across all sectors of the economy.

The Committee has noted and applauds the government for the recently announced changes in making Canadian exploration expenses deductions elective, which will allow resource companies to carry forward exploration costs rather than having to expense them in the year in which they are incurred.

Canada has undergone intensive mineral development over the past few decades and, as a result, the easy-to-find, surface and near surface ore bodies are a thing of the past. Canada still has excellent potential for discovering ore deposits, but they are becoming progressively more expensive (Fig.8)¹⁰ and difficult to find. New and better exploration techniques must be developed. Recently, the industry took action to encourage exploration R&D at the industry-wide level through the Mining Industry Technology Council of Canada (MITEC). The project is an extremely small one however, with a first year (1992) administration budget of only \$192,000.

In the past, much of Canada's geophysical exploration expertise has been developed by small companies who competed for exploration contracts from both senior and junior exploration

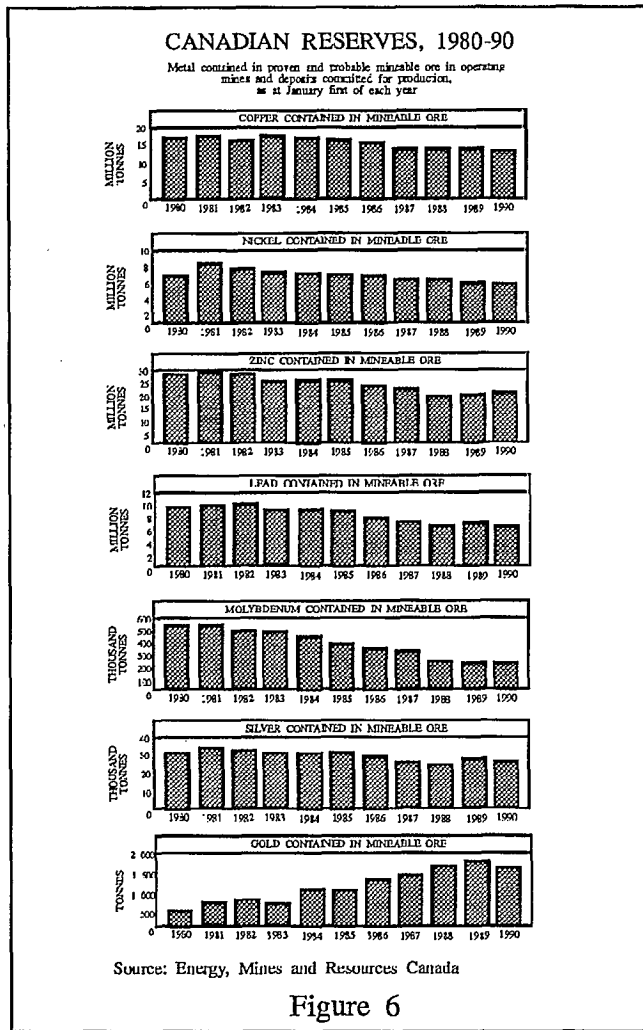


Figure 6

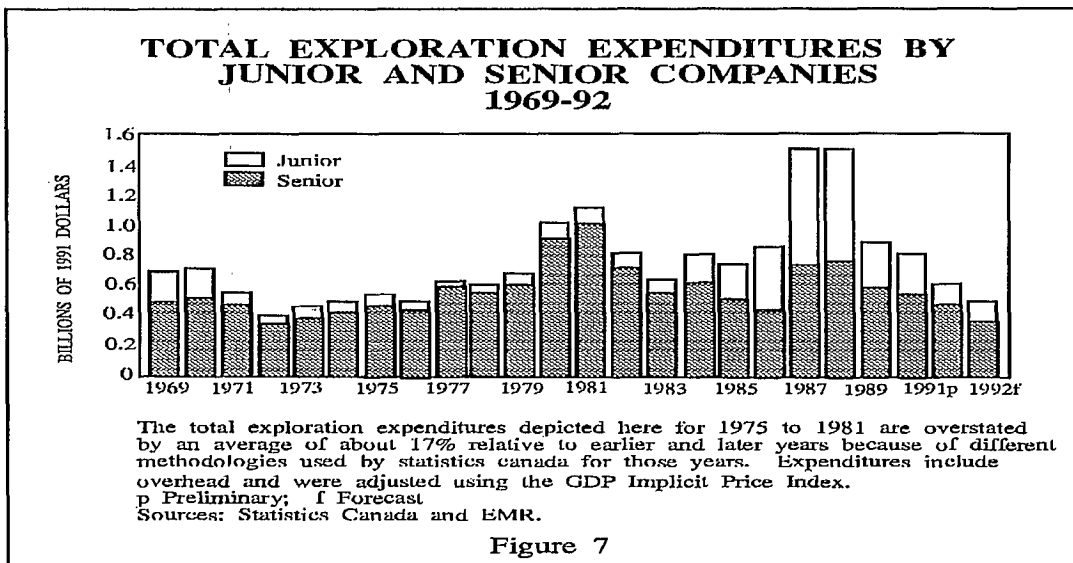


Figure 7

companies. Even some of the largest firms with well developed exploration departments would contract out to small companies to obtain the benefit of special technology. The Canadian mining industry and the specialized consulting engineering firms associated with it have earned world-wide recognition for their exploration expertise and geophysical exploration techniques. Canadian companies have not only been highly successful in the discovery of new mineral deposits in Canada, but have made important discoveries in the U.S.A., Chile, Australia, Asia and Europe. The fact that many Canadian companies have a dominant position in the Nevada gold fields is an example of Canadian companies' ability to compete favourably with the large and mature American mining companies.

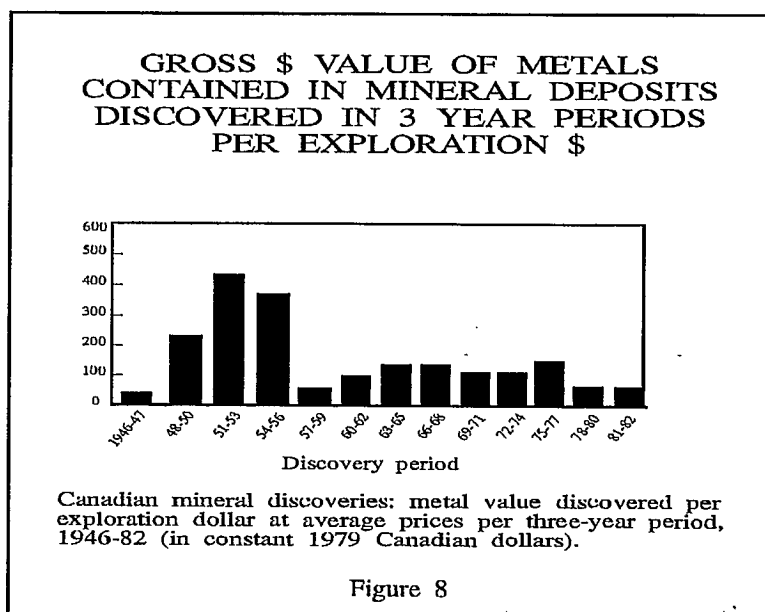
The industry as a whole is assisted by the Geological Survey of Canada (GSC) in the Department of Energy Mines and Resources (EMR). The Mineral and Continental Geoscience Branch of GSC maintains expertise concerning the nature and origin of mineral deposits of Canada to facilitate their exploration and development, land-use planning and policy formulation; it sets standards and undertakes contracted regional geochemical surveys and

airborne radiometric surveys; and it maps and documents the surface geology and deep geology and geophysics of the Canadian Shield and other parts of the country.

The Branch develops innovative guidelines and techniques for mineral exploration, and operates national centres for geochronology, petrology, paleomagnetic studies, mineralogy and analytical geochemistry. Industry has praised the work of the Geological Survey both for meeting the needs of the industry and for providing quality data, even though the exploration technology budget of the department is small relative to total departmental expenditure. All mineral exploration activities amount to \$10 million per annum compared to the total departmental budget for science and technology activities of \$350 million.

5.1.2 Sustaining forests

The Canadian forestry industry could do much more to sustain its forests. More advantage can also be taken of the expertise within our government and university laboratories to develop and breed higher quality tree stocks in a manner equivalent to what has been done in agriculture over the past century. The climate of Canada



and the relatively short growing seasons were taken as challenges by agriculturists and breeders. They succeeded in developing strains of various crops which thrive under Canadian conditions and have made us a "breadbasket of the world".

Why has there not been development at the same scale within the forest industry? One of the reasons brought to the attention of the Committee is that responsibility for forests in Canada is divided among so many different players. Of Canada's 244 million hectares of land available for logging, 11% is owned by the federal government, 80% by the provinces and only 9% by private owners, i.e., individuals and corporations. Control over logging methods is essentially a provincial responsibility. There is no federal legislation covering logging on private land and few fiscal incentives to encourage ecologically sound woodlot management, yet most of the R&D related to forestry is conducted in federal laboratories.

At the provincial level, the use of forested land is governed by various Acts and administered by various departments. Forestry companies are typically granted long-term permits and leases with harvesting rights to crown lands¹¹, but since they are not the owners, as farmers are on their lands, they have not treated forested lands in the same proprietary way to ensure long term productivity. Basic forestry, that is, replanting or regenerating logged-over areas, is required of forestry companies in all provinces, but intensive forest management has been lacking because, due to the forest tenure system in Canada, there is no retained economic interest by the companies in making such investments.

Today commercially exploitable stands of timber are located farther and farther from existing mills and the costs of production are rising. High quality, large-diameter logs are harder to find. In 1850, the average tree felled east of the Rockies yielded 440 to 500 board feet of lumber; today the average tree rarely yields more than 70 board feet. Part of this difference is due to the

introduction of new technologies such as feller/bunchers and advances in sawmill techniques which allow the use of smaller trees.

Supply problems are also aggravated by the devastation caused by insects, disease and fires. These three causes annually reduce the available stocks by an amount equivalent to that which is harvested, and the forests which grow naturally to replace the original stands usually are of lower quality, are of less desirable species and are less resistant to insects and disease.

The productivity of Canada's forests has been estimated as 60% lower than that of Swedish forests and is also lower than that of American and Russian forests. We are losing the competitive advantage which came from vast supplies of available high quality forests. The obvious solution is more intensive and extensive forest management. Intensive forest management means that higher quality timber can be produced in a shorter time using less area. Experience in Canada and in similar northern forests elsewhere has demonstrated that gains in volume of 50%, 100% or more can be achieved¹². Norway, Sweden and Finland harvest an amount equivalent to about 70% of Canada's annual production from an area one-quarter the size of Canada's productive forest land¹³.

Forest management in Canada began only in the 1950's, and only in a limited and sporadic way, well after many of our vast forests in the Maritimes, Quebec, Ontario and BC had been harvested. Forestry firms and governments in other countries, most notably in Scandinavia, have been practising intensive reforestation and forest management for a considerable length of time. This has given them strong competitive advantages.

The know-how to protect our forest resource and to generate greater and more sustainable yields from our forests exists in Canada today. To make more effective use of this knowledge and know-how, the federal and provincial governments

must join forces with industry and with the universities in a concerted and cooperative program of forest development. Most of the funding for forestry and silviculture research is currently being spent by the federal government with the provincial governments and industry playing smaller roles. The challenge is to create a better transfer of the technology into the forest resource community and to ensure its effective and intensive use by the firms in the sector. Nothing less than the survival of the industry is at stake.

RECOMMENDATIONS:

The Committee recommends that:

- a) *because the non-ferrous metals industry is in a crisis, the Department of Finance should promote investment in mineral exploration through tax or other incentives which help to make Canada as attractive for exploration expenditures as other countries. These incentives should specifically target those base metals whose reserves are in decline.*
- b) *ISTC, EMR and Investment Canada, in cooperation with provincial governments, should benchmark the Canadian investment climate (including financial, environmental, incentives, and other policies) against those of other countries such as Mexico, Chile and Bolivia for the mining and minerals industry; and Scandinavia, the United States and South American countries for the forestry industry; to determine whether the Canadian investment climate is competitive and what policy adjustments could be made in order to attract more exploration and development investment to Canada.*
- c) *resource industries in the mining and minerals sector should collaborate in exploration technology R&D programs with government (EMR and the National Research Council (NRC)) and university laboratories, where market potential can be identified and where the direction and at least some of the funding are provided by industry.*
- d) *EMR should allocate a higher percentage of its laboratory resources to exploration technology research.*
- e) *forestry and forest product firms should establish collaborative co-funded research programs with the Department of Forestry, provincial departments of Natural Resources and universities and colleges to develop the technology to achieve a better yield of wood and fibre from land that is allocated to forestry.*
- f) *the Forestry Research Advisory Council of Canada (FRACC) should be given more authority over the selection and direction of the research programs being undertaken by that department. Both the FRACC and the Minister's National Advisory Council on CANMET (MNACC) should provide their annual reports to industrial firms and to their associations in order to increase awareness of the work of the government's labs and to encourage more collaboration.*
- g) *ISTC should improve assistance services and programs which encourage research collaboration between resource companies and government and university researchers.*

5.2 ENVIRONMENTAL REGULATION

Cooperation rather than Confrontation

The managers of resource industries understand and accept that environmental regulation is a business requirement as well as a social and moral responsibility. Indeed, in some cases new enterprises have developed around environmental regulatory requirements and, in the process of adapting to more rigid standards, some firms have

created productivity improvements. Unfortunately these are more the exceptions than the rule. In most cases, the concern of the public to protect the environment places numerous constraints on the natural resource industry. These constraints can roughly be divided into two separate components: pollution controls, and land use and access controls.

In forestry, environmental regulation limits logging operations, emissions from mills and processes used in paper making, and even reforestation. In the mining industry, mine development, all phases of extraction and processing, and reclamation of the mining site are all influenced by environmental issues. While recognizing the necessity to regulate the impact of industrial activity on the environment, the managers of Canada's resource industries point out that the uncertainty and economic risk associated with the inconsistent application of "environmental assessment" processes are discouraging investment and are impediments to competitiveness.

Industry executives told the committee that there is not enough "transparency" in the standards and guidelines for compliance. In B.C., for example, the process for acquiring permits to establish new mines takes up to two years. The applicant has no way of knowing at the onset of the approval process what the regulations will be, the amount of time that the approval process will take, what it will ultimately cost, or what the outcome will finally be.

There are serious problems with jurisdictional overlap between federal and provincial authorities and between departments at both levels of government. A sub-committee of the Canadian Council of Ministers in the Environment looking at "harmonization of regulatory and technical approaches" has been unable to resolve any significant issues in two years of meetings. Such lack of progress is exacerbated by generally poor communication and consultation between the

industry and departments responsible for environmental and conservation legislation¹⁴.

The regulations themselves are often designed to satisfy public pressure groups or to deliver on political promises but may, in some instances, not be based on solid scientific principles. Recent regulatory decisions regarding the chlorine content in paper-making processes have been made, for example, despite the lack of conclusive scientific data and evidence. As a result, major capital expenditures will be required by several companies to achieve emission levels which may prove to be unnecessary for public health and environmental concerns when all the facts are known. Moreover, pressures from the marketplace where "green" issues are increasingly promoted may, in the end, dictate what are deemed to be acceptable standards and practices, instead of common sense and scientific knowledge.

From the point of view of the industrial leaders, this situation is unacceptable and a great impediment to global competitiveness for the entire industry; however progress is being made to overcome at least some of these problems. For example, the committee has noted with approval initiatives such as the MEND program (Mine Environment Neutral Drainage), in which the leading mining companies are working in concert with both the federal and provincial governments to address the estimated \$5 billion problem of acid drainage from mine tailings. Funding of the \$18 million R&D program is shared by 17 mining companies who are putting in 40%. The program is strongly encouraged by the Mining Association of Canada and the Mining Industry Technology Council (MITEC), the Federal government (36% of the funding), and the provinces of Ontario, Quebec, B.C., Manitoba and New Brunswick (24%). EMR/CANMET is providing the secretariat as well as a major portion of the federal share towards the costs of the program.

RECOMMENDATIONS:

The Committee recommends that:

- a) the Department of the Environment and provincial departments responsible for environmental matters should jointly and urgently address the problem of overlapping and conflicting jurisdiction over environmental standards, regulations and enforcement.
- b) federal and provincial departments responsible for environmental matters should come to an early agreement on national environmental standards, together with accompanying regulations, and that, where possible, the enforcement of these regulations and standards should be the

prime responsibility of only one level of government.

- c) the impact on the economic competitiveness of a project or an industry should always be included and considered as a factor of major importance in the evaluation by relevant authorities of any environmental regulation or permitting process.
- d) government laboratories should continue to perform research for the public good which assists in the establishment of well-founded policies and regulations to protect the health and safety of Canadians and the Canadian and world environment. In this work they should consult and collaborate with industry to be more aware of the economic impact of potential regulations.

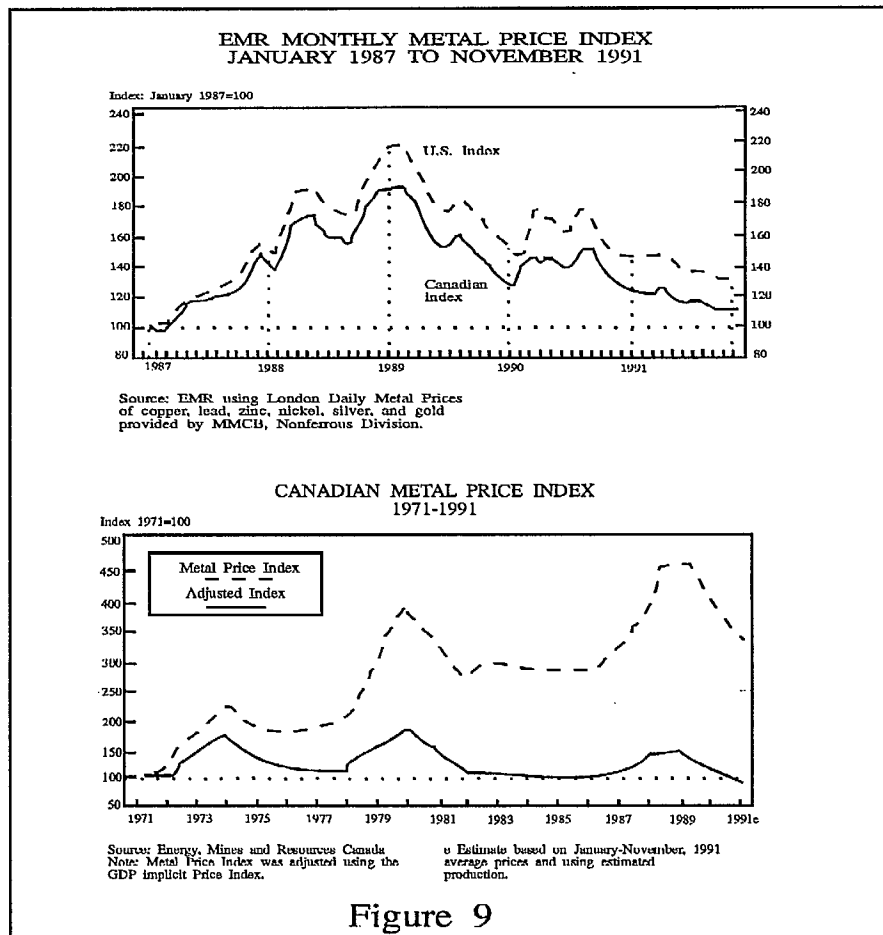


Figure 9

SQUEEZED OUT BY LOWER COST PRODUCERS?

PERCEPTION:

Canadian resource companies are being squeezed out of existence by declining world prices.

REALITY:

Underlying all of the discussion about the future of the mining industry in Canada is the question of metal prices. It has been widely stated by the Science Council and others that commodity prices in general, and metal prices in particular, are declining in real dollar terms. This is undoubtedly true, depending on which period one chooses and whether one considers peaks and valleys. Accepting that prices have declined in real dollars over the past ten years, the questions that are obvious but seldom addressed are why, and will this trend continue.

Metal prices peaked in 1989. Since then, they have fallen considerably along with most other commodity prices (Fig. 9, 10)¹⁰. These lower prices are largely a reflection of reduced demand due to poor economic conditions throughout the world. Demand for metals will increase when the world economy gains strength.

If prices are declining and supplies continue to be produced, it must be true that the cost of producing minerals has been declining. In the case of copper, the average world price in 1981 was 79.6 cents per pound and the ratio between the price of copper and the weighted average cost of world copper production was 1.04:1. In 1991, with an average copper price of \$1.06 per pound, the ratio of price to cost is 1.35:1. Therefore, in real dollar terms, production costs have declined at a rate greater than have copper prices.

It is obvious that if the world average cost of producing metals exceeds the price for a prolonged period, production will fall and prices will increase. In this process, however, the least cost competitive suppliers may be squeezed out permanently. The challenge for the Canadian mining industry and for Canada is to ensure that we remain competitive with the rest of the world's mineral producers by keeping production costs at a level compatible with world metal prices. Accomplishing this with our natural disadvantages such as climate, infrastructure, and transportation distances is not a simple task and will require the full cooperation of corporations, unions and governments. It is possible, however, as INCO has proven by reducing its mining costs by half over the past ten years.

In the Forestry sector the price, supply and demand of newsprint has exhibited a long term climbing trend, although the price peaked at about \$600 per tonne in 1988, fell to \$560 per tonne in 1991 and has yet to recover to 1988 levels.

Canadian mills are paying higher costs for fibre than those of the southern United States and South American countries, but lower than those paid by Scandinavians mills. The inefficiency of out-of-date and undersized papermills is the leading source of cost pressure on the pulp and paper industry in Canada, and this can be overcome with plant modernization.

Lumber producers are facing the challenge of accessing timber resources in more inhospitable areas which are farther from established transportation facilities. Much more needs to be done in Canada to re-establish desirable forests in logged-over areas. We can no longer afford the short-sightedness of both industry and government which prevailed when the supply of trees seemed inexhaustible. Modern forest management practices are as necessary to the forestry industry as total quality management is to manufacturers. It has become a universal business practice; those who fail to recognize this are doomed to fall by the wayside.

5.3 VALUE-ADDED OR FORWARD INTEGRATION STRATEGIES

Adapting to the new competitive environment

5.3.1 Adding-value and forward integration

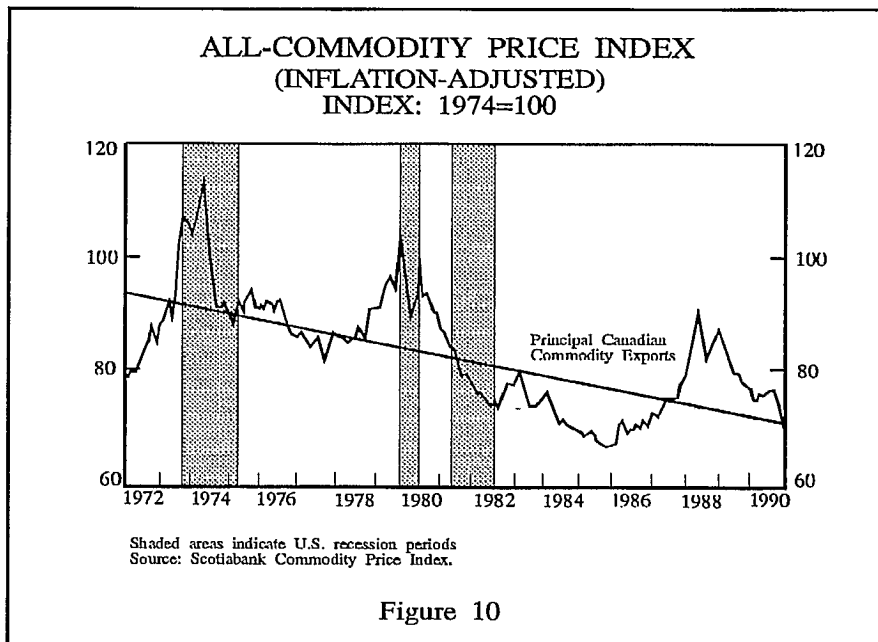
A constant theme has recently appeared in technology policy papers which discuss the future of the Canadian resource industries. These reports hold that there is no future in supplying raw materials; that Canadian firms must "forward integrate" or move into downstream applications and create value-added products. Although the two expressions are often used interchangeably, there is a significant difference between added-value and forward integration. Added-value refers primarily to the output product, whereas forward integration relates to the nature and scope of the firm as a whole.

There are many ways to add value to a commodity product. Most of these are measured from the perspective of the customer of that product. The resource company which is able to adjust its specifications (shape, size, composition,

etc.) to better fit the needs of its clients is adding genuine value to its product. So is the company which provides better customer service or assists the client in making a better profit from its products. Where basically similar commodities are being sold with limited margins in a very competitive pricing market, these added values are often the only way a resource company can create a favourable market position or competitive advantage.

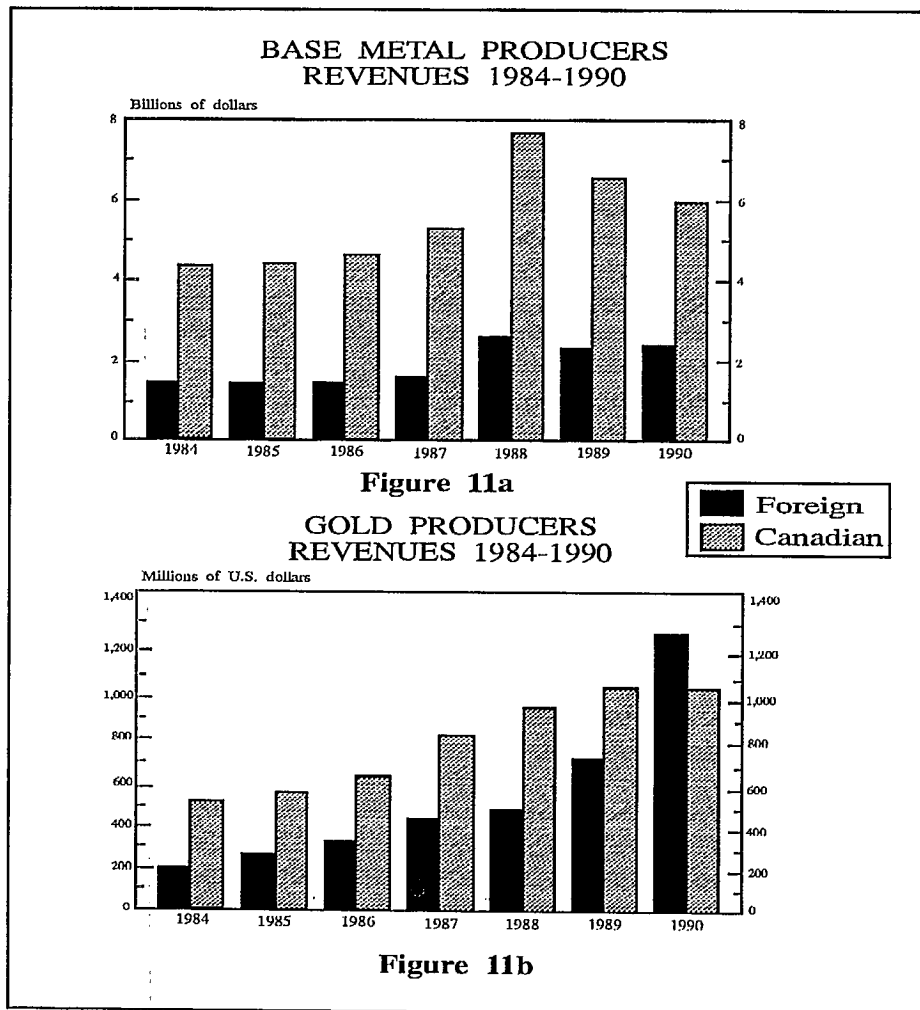
Adding value can also mean producing downstream products from the materials which the company produces. This is a forward integration strategy; however, such a strategy sometimes means entering the marketplace of one's customers and moving out of the markets where the company is most knowledgeable and competent.

The thesis of the policy papers and reports encouraging value adding or forward integration is that reliance on commodities alone makes Canadian resource-based firms vulnerable to world market fluctuations and to declining real revenues in the longer run. With commodity



prices either in decline or flat^b, (Fig.10)¹⁵ [see box on page 21] and employment opportunities disappearing, the Science Council Sectoral Technology Strategy Reports^{8,16} and the Michael Porter Study² all propose that diversification within the resource-based industries is necessary to ensure their ongoing contribution to economic wealth. These reports rely heavily on the Japanese model where the non-ferrous metals industry has been transformed from primary mining into manufacturing and development of new products and uses for the basic commodities. This proposed "forward integration prescription"

has stirred much debate and controversy in industry and government circles. Most industry executives believe that the Science Council's reference to the Japanese strategy of forward integration into manufacturing is largely inappropriate to Canada. Due to numerous factors, Japan has mined itself out and now sources raw materials from around the world. Unlike Canada, Japan has a strong manufacturing base to complement a forward integration strategy, and Japanese smelters and manufacturing centres are all close to or on tidewater, making it relatively inexpensive to



^b Figures over the longer term (80 years) show that, despite substantial fluctuations, the trend for most commodities has been roughly flat. Recent technological changes and market globalization, however, argue against dismissing the downward trend of the past twenty years as merely a fluctuation.

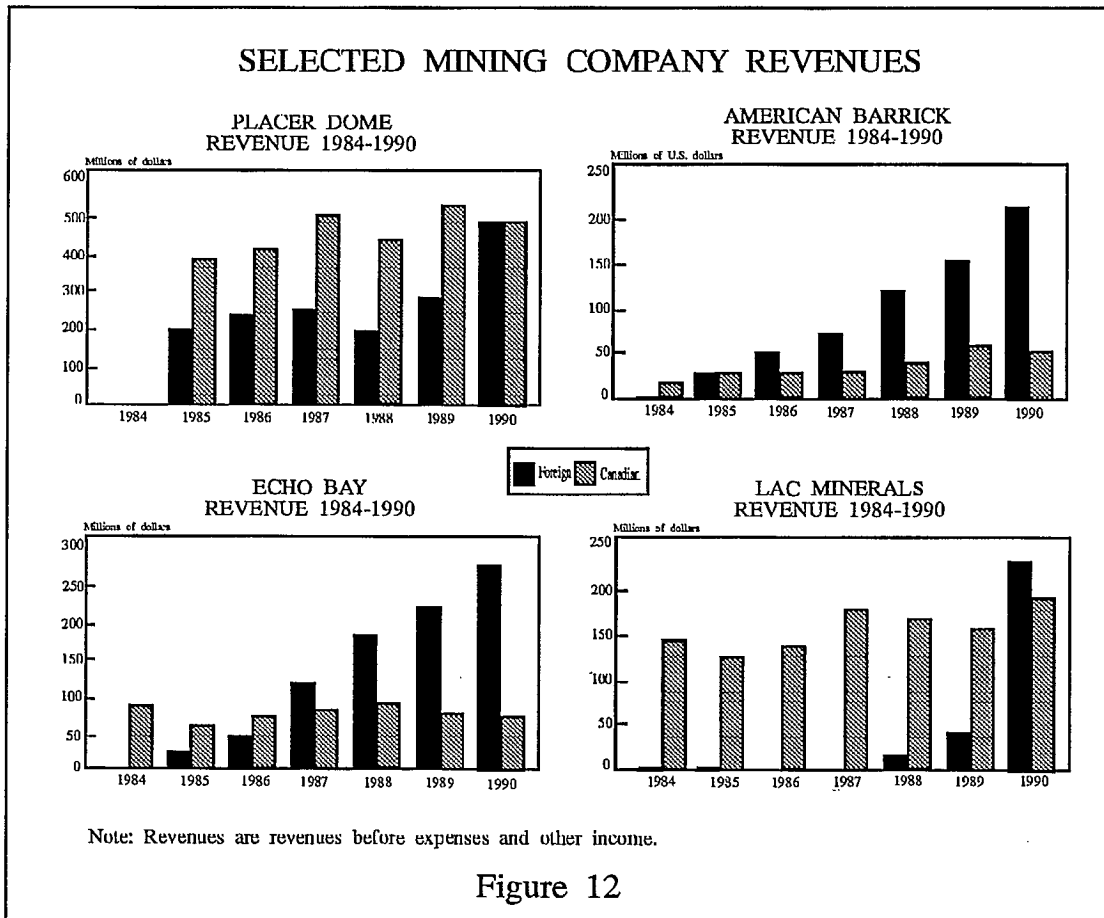
import feedstock. Japan also has a much larger and well protected domestic market as well as near access to a rapidly growing Asian market for resource-based products.

Industry representatives argue that Canada's relative strength lies in the primary phases of the business where we are among the most efficient producers in the world. In non-ferrous metals, the industry's world renowned expertise in exploration and mining technology is our comparative advantage. This view is supported by the success that Canadian firms enjoy in the international mining market. Foreign revenue is becoming a larger percentage of the sector's overall revenue picture (Fig.11 & 12)¹⁷. Similarly in forestry, the industry has concentrated on science and technology which create operational efficiencies, innovative paper

making technologies and good forest management. As a result they have become experts in these areas.

5.3.2 Forward integration by resource companies

The Committee has learned that several Canadian companies attempted expansion and diversification during the profitable years of the 1980's. Where this expansion was in the form of adding value to basic products to satisfy customers, they were generally successful. But, where the expansion took the form of a diversification into slightly related or unrelated business areas, in many cases they failed. These failures were blamed on lack of management and/or marketing skills for the new businesses.



The Committee has seen examples where both added-value and forward integration strategies have been successful in highly specialized, niche markets; these cases demonstrate what is possible: Alcan completely redesigned the specifications for its semi-fabricated sheet aluminum product to meet the requirements of its clients. Cominco has developed new lead-acid battery manufacturing processes and new alloys for use as bearing material. Sherritt Gordon, building on its recognized international reputation in nickel alloys research, has formed a consortium with ISTC, the Province of Alberta and the National Research Council of Canada (NRC) to initiate the Westaim Centre for the development and commercialization of advanced materials. INCO has developed new nickel products that include alloys, powders for batteries and nickel-coated carbon fibres for use in a variety of industries throughout the world. Weyerhaeuser Canada works closely with clients such as Xerox and IBM in developing speciality papers to suit new telecommunications technology.

In all of these examples, innovative firms have identified the needs and demands of the market and have used science and technology to develop or help their customers to develop competitive products. Nevertheless, many Canadian resource companies have not been as proactive in adding value or in the development of downstream products as their competition in the U.S, Europe and Japan.

Canada's resource-based economy has contributed significantly to, and continues to support, regional development. The challenge of opening up remote regions and providing transportation of natural resource products has been an important catalyst for the design and development of sophisticated world-class transportation and telecommunications infrastructures. A successful forward integration strategy should not cause the loss of the viability of regions which rely heavily on the primary phases of the industry.

The Committee recognizes that, although the wholesale adoption of a forward integration strategy is no panacea as a transformation mechanism for the entire resource industry, public policy must recognize and support its strategic importance. The concept of forward integration, i.e., transforming Canada's resources into ever more sophisticated products in response to market needs, must be encouraged, but in this process we must continue to support and encourage our natural advantage which derives from the vitality and profitability of our basic resource exploration, extraction and exploitation industries. In other words, encouragement of adding value to current materials should be integrated with support for the basic industries in their traditional form.

5.3.3 Forward integration and secondary manufacturing

Downstream product development is normally carried out by the customers of the resource industries. In the past and to a lesser extent today, tariff and non-tariff barriers have discouraged the development of a healthy secondary manufacturing sector in Canada. This has been the legacy of the policies of some of our major trading partners, who have protected their own manufacturers by discouraging the importing of finished goods while encouraging the flow of raw and semi-processed materials.

A downstream or forward integration strategy in Canada depends upon the establishment and encouragement of a healthy domestic secondary manufacturing and engineering services sector. The government must continue in its efforts to remove the barriers to trade of value-added products and support those firms which are the Canadian customers for the output of the resource industries. At the same time the resource industries in Canada should be proactive in seeking alliances with Canadian secondary manufacturers, working with them to develop new, more competitive uses and applications for resource materials.

5.3.4 Forward integration and the role of government

Government science and technology support for the industries is organized according to the various phases of the industry. The Federal Department of Energy, Mines & Resources focuses on improving and developing mining and metallurgical technology at the primary or commodity phases of the non-ferrous metals sector; Forestry Canada concentrates on forest management and wood processing related technologies. Both departments have been praised by industry as supportive in developing a competitive science base, and the Committee has noted that EMR has an active system for keeping in touch with its clients through various advisory councils, conferences and forums. Industrial spokesmen have pointed out, however, that EMR's linkages into manufacturing or product development have been secondary to their focus on environmental, health and safety technologies, although in recent years, this focus has shifted.

ISTC supports the development of technologies for downstream products through programs such as the Advanced Industrial Materials Program (AIM), the Technology Outreach Program (TOP) and the Strategic Technology Program (STP). The National Research Council's Industrial Research Assistance Program (IRAP) also supports the development of new technology, products and processes.

Industry executives believe that Government departments and laboratory institutions which are organized around traditional commodities technologies have failed to encourage or support their efforts to venture into forward integration strategies. Government S&T support is not cohesive enough to assist the industry to adopt incremental value-added strategies. To address this deficiency, government laboratories should adjust the balance of their research programs. Working in consultation with the resource companies of Canada and downstream manufacturers, they should explore potentially

profitable avenues of downstream product development. At the same time, current programs supporting processing and exploration technologies should be maintained where these are contributing to competitiveness.

Government policy should encourage investment in those parts of the basic resource industries in Canada which are or have the potential to be internationally competitive and should not support sub-marginal and inefficient plants, such as outmoded, unproductive pulp mills or smelters.

RECOMMENDATIONS:

The Committee recommends that:

- a) *the Department of Finance and Investment Canada should work to establish an attractive and competitive investment climate in Canada to encourage investment in the basic resource industries, and do everything they can to provide a stable environment for the development of these industries which are considered to be of prime importance for the continuing wealth of Canada.*
- b) *government support should be directed only at those firms and operations which are of a scale and quality to be internationally competitive and not at sub-marginal and inefficient plants.*
- c) *ISTC should work with the Department of Finance, EMR and Forestry Canada to establish effective policies to encourage resource companies to forward integrate into value-added specialty products where market conditions are favourable.*
- d) *ISTC, working with EMR, Forestry Canada and NRC, should design and implement policies to encourage the development and growth of secondary manufacturing companies which create value-added products based upon Canadian resources.*

- e) *resource companies should collaborate with Canadian secondary manufacturers to determine how to add greater value to their materials and should work with their domestic customers to develop new competitive downstream uses and value-added products derived from resource materials.*
- f) *resource companies should collaborate with and provide direction and funding to the research programs of the laboratories of EMR, Forestry Canada and NRC so that these are applied in a more balanced way to both upstream and downstream technology development, supporting exploration, extraction, transportation, upgrading, refining and subsequent product development, particularly where there is identified market potential.*
- g) *the laboratories of the federal government should be more proactive in assisting both resource and manufacturing companies in Canada to develop the industrial processes and products which will maximize the economic returns to Canada from the development of our natural resources, while minimizing disruption to the environment.*

5.4 UNIVERSITIES AND OTHER POST-SECONDARY EDUCATIONAL INSTITUTIONS

Unfocused Potential

Forestry and mining business leaders generally do not consider researchers in many Canadian educational establishments to be sufficiently responsive or adequate to cope with the new competitiveness issues. They point out that in their attempt to cover many and diverse fields, the universities have developed a "smorgasbord" of research capabilities which is far too broadly based and therefore not particularly adequate in the depth and breadth of its expertise for any specific field.

In spite of this, industry has funded a considerable amount of university research through the Federal Matching Program of the Natural Sciences and Engineering Research Council. Also, the recently launched program of Networks of Centres of Excellence has created good university/industry linkages in strategic research. For example, the Mechanical and Chemo-mechanical Pulp Network which has been built around the Pulp and Paper Research Institute of Canada (PAPRICAN) is considered important in forestry, and industry has considerable input into their research programs. The forestry research programs at the University of British Columbia and at McGill are also highly regarded as is the mining engineering program at Laurentian University which works in conjunction with INCO.

RECOMMENDATIONS:

The Committee recommends that:

- a) *universities should collaborate with each other and with industry to assure that resource-related research programs are focused with a view to the achievement of world class stature, and that research programs are not duplicated across different institutions.*
- b) *performance rating and promotion of staff in educational institutions should include credit for work done by professors on behalf of or in collaboration with industry partners.*
- c) *industry-led Advisory Boards should have budgeting authority in programs designed to support interaction between educational institutions and industry; that industry should have input into policies and directions of longer term research; and that industry personnel should be included in the review and selection process for entrepreneurial research projects within educational institutions which are intended to enhance Canada's competitiveness.*

5.5 GOVERNMENT AND INDUSTRIAL LABORATORIES

The Bridge to Downstream Development

The federal government supports resource industry research through a variety of funding structures. Government laboratories receive all or most of their funding from public sources. The National Research Council (NRC) is almost totally funded through government budget allocation. Approximately 20% of the operating budget of CANMET in EMR comes from contract work from outside sources. PAPRICAN and Forintek are private industry-sponsored laboratories with some public funding. PAPRICAN receives 10% of its budget from public sources and the government provides Forintek with rent-free facilities and contributes to its research program. FERIC, the Forest Engineering Institute of Canada, receives about 42% of its budget from public sources in the form of contributions to its research programs.

Government funded laboratories and government funding of industrial laboratories should support two competitiveness strategies. They should develop new technologies, processes and products that benefit industry as a whole and they should develop technologies that assist the industry to comply with health, safety and environmental regulations.

Industry perception of the importance of these organizations to their competitiveness seems to be reflected directly in the amount of industry funding the laboratory receives. The more industry funding, the better and more useful the laboratory is generally perceived to be. Forestry industry representatives, for example, report favourably on the relevance and value of PAPRICAN. It undertakes an extensive program of cooperative, generic research for the industry as a whole and some specific development contracts directly for individual clients. Research decisions are kept focused and relevant by an advisory board of industry officials. Federal

government contributions to PAPRICAN are directed towards environmental stewardship and silviculture research.

Industry views on CANMET were mixed. Some industry spokespersons felt that CANMET has been a good resource on a limited "scientist to scientist" basis for specific problem solving. Others, particularly those larger mining companies with substantial research capabilities of their own, felt that CANMET's research work had shown little direct research benefit for them in the past. However, most industry executives recognized that CANMET's facilities have recently shifted towards improved government/industry collaboration on research priorities.

Members of the Minister's National Advisory Council on CANMET (MNACC) report that CANMET has, in the past few years, made significant improvements in increasing its responsiveness to industrial concerns, and regularly adjusts its research programs to match the interests and needs of industry. Today MNACC plays an important part in shaping the research program of CANMET.

Both forestry and mining representatives believe that the National Research Council does very little research that is commercial in nature. NRC research programs, however, are addressing areas of particular importance to resource based industries. These include automation, biotechnology and silviculture, advanced materials, and information technology. The question therefore is how can the various government research efforts be made more relevant and more responsive to the needs of the industry?

A previous NABST study¹⁸, the report of the Federal Science and Technology Expenditures Committee, 1990, recommended a restructuring of federal support for government laboratories. The report called for the creation of "Science and Technology Institutes" which were separate and autonomous from their departments. The department would establish a contractual

relationship with the institute to perform specific research activity required by the department for policy and regulatory matters. The institute so created would also be freed from many of the policy and procedural constraints which limit its ability to interact in a business-like way with industrial clients, and to profit from that interaction.

RECOMMENDATIONS:

The Committee endorses the recommendations of the NABST report on Federal Science & Technology Expenditures (Lortie:1990) that each government laboratory should have:

- a) *Institute Status - that it be autonomous with its own board of directors and its own chief executive officer, who would be responsible for the operations of the laboratory.*
- b) *A Contractual Relationship - the laboratory should enter into specific contracts with the department which it serves. The contracts would spell out clearly what services are to be supplied by the laboratory as well as the fees to be paid for these services.*
- c) *A Revenue Dependency Funding Relationship - the laboratory would be paid in a business-like manner for the work it does either by the government department it serves or by industry which would also be encouraged to contract with the laboratory for execution of specific projects.*
- d) *A Management Structure - as an autonomous entity, the laboratory would be able to enter into contracts, would be responsible to perform in a satisfactory manner in order to retain its clients, and would be able to retain the earnings generated by its services, to be used as its officers determined to be most beneficial for the laboratory.*

- e) *An Evaluation Regime - the board of directors and chief executive officer would also have the responsibility and authority to evaluate the quality of personnel in a recognized manner in order to guarantee the highest standards of excellence at all times.*

In connection with item a) above, the Committee further recommends that the board of directors of such an institute comprise, at least partly, independent senior staff members recruited from the industries the institute would normally serve.

5.6 HUMAN RESOURCES

Our Most Important Natural Resource

There is growing, almost universal recognition in the resource industries that their future competitiveness will depend, as never before, on the quality and training of the personnel employed in their companies.

NABST has already issued one report dealing with this subject: Learning to Win: Education, Training and National Prosperity, April, 1991. Another NABST Committee has ongoing studies into other aspects of the need to improve the quality and availability of qualified personnel in Canada. They will shortly be issuing reports on Immigration of Qualified Personnel and on Winning with Women in Trades, Technology, Science and Engineering.

Two human resource issues were identified as influencing competitiveness in the resource industries:

- The importance of an education system that produces a technically competent workforce and a public appreciation of our resource based economy.
- The role of on-the-job training to ensure a continued mastery of technology.

5.6.1 The Education System

Senior executives of the resource industries in Canada believe that a technologically competent work force is one of the greatest assurances of maintaining global competitiveness. Employees must possess the technical literacy which will allow them to participate effectively and enthusiastically in the process of technological change and innovation. This technological competence and confidence is built on a solid educational foundation of recognized standard. Our education system must be revamped to include a system of national testing standards to facilitate regular evaluation of the proficiency of our students.

A major impediment to competitiveness is the lack of appreciation of the value of technical craftpersons (technologists) and trades. In European cultures, trade and technology personnel enjoy high status and the respect of the population. This encourages young people to aspire to technical trades which in turn produces a high standard of excellence from this group. We have no such "trades culture" in Canada. The Committee applauds the recent extension of the Canada Scholarships Program to Community College Technical Programs in addition to University Degree programs, as a step toward recognition of the importance of trade and technology personnel.

The committee, during its study, became aware of a disturbing trend in the attitudes of young Canadians. A large and growing number of students who are concerned about the protection and preservation of the environment have a tendency to view the resource industries of Canada as "the enemy". This has discouraged young people from aspiring to select those courses which would contribute to developing the skills they need to be effective potential employees of the resource industries, where they would be able to put their concern for the environment to good use.

As stated earlier, Canada's economy still relies to an extraordinary extent on its comparative advantage in natural resources. Elementary and high school students should gain an understanding and appreciation of this through expanded social studies, economic history and geography, geology and forestry content in their curricula. The trend to a lower participation rate of students in science programs, particularly earth sciences and forestry, is reducing the supply of prospective students for careers in these sectors. At a more general level, the lack of public understanding of the importance of the resource industries to the economy is leading to lack of supportive public policy.

Primary school training should be designed to instill a pride in our young people regarding our abundance of natural resources. They should also be taught that the importance of environmental controls was not understood in the past, but it is understood today. They should be led to understand that science and technology are the keys to cleaning up and keeping our environment clean, as we continue to develop our natural resource industries while maintaining our excellent standard of living.

The committee is convinced that the overwhelming anti-industry messages of the environmental movement need to be balanced with an accurate perspective on the importance and value of the resource industries. Canadian students need to hear that these industries are seriously addressing legitimate environmental concerns and, in fact, need the services of an "enlightened" workforce to assist them to develop their industry in ways that are safe to the environment.

5.6.2 On-the-job training

The resource industries are technology intensive. The industries use state of the art technologies in disciplines as diverse as micro-electronics, biotechnology, robotics, telecommunications and others. The application of these technology tools means that all jobs now require technical

competence. While the education system can provide numeracy and literacy skills, the ever-changing nature of technology means that industry has the responsibility for developing ongoing mastery. Innovative corporations recognize that the development of a corporate culture of competitiveness begins with the base of a competent, skilled workforce.

Effective career paths include formal training and on-the-job experience where a "constant improvement" approach prevails. Life-long learning is a concept which NABST has supported in its earlier Report of the Human Resources Committee "Learning to Win: Education, Training and National Prosperity".

The responsibility for ongoing worker development is one which must be accepted by both management which needs better trained employees and the employees themselves who are responsible for their own self-betterment.

Firms that are successfully dealing with globalization have integrated ongoing training with job responsibilities. INCO has an intensive, multi-year training program which equips employees for underground mining positions. Technology is transforming these traditional "pick and shovel" jobs into remote control monitoring and computerized manipulation of machinery.

The traditional focus on upgrading technical skills of individuals is being complemented by "team development". Corporate training is directed towards getting people to work together innovatively in work groups in a "total quality management" environment. This new emphasis on team problem-solving and quality focus is paying high dividends in terms of more extensive innovation.

A major barrier to firms investing heavily in job training is the concern that they will be doing it for the benefit of competitors who will hire away the employees that they have trained. The sector reports prepared by the Canadian Mining

Association and the Forest Sector Advisory Council for the Prosperity Initiative¹⁹ identified this as a major source of concern among resource industry employers.

To offset this concern, the Economic Council of Canada has put forward a unique proposal to encourage investment by corporations and individuals in ongoing training. They propose an "Employee Training Loan Insurance Scheme" wherein the government advances a loan to cover training costs. As long as the employee does not leave the firm voluntarily, the firm is responsible to pay back the loan over some agreed period of time, say five years. If the employee does leave during the five year period, then repayment of at least the balance of the loan becomes the employee's responsibility; however it could be passed on to his or her prospective employer as a pre-condition before accepting the new job²⁰.

Some union organizations have expressed a preference for a taxation-based system where all employers pay into a training fund, whether they draw upon it to re-train their workers or not. They regard this as more equitable and one which gives more responsibility and incentive to the employer to be concerned about the ongoing development of its staff. Those firms which take best advantage of the funds to improve their workers would benefit the most.

Managers and management groups within the resource industries have told the Committee that they oppose the imposition of any new tax which would add to their base-line costs independent of their profitability. Instead, they insist that their levels of investment and the timing of staff development and training are aspects of their competitiveness strategies which must remain prerogatives of the firm.

The provinces have instituted apprenticeship training programs which lead to certification as journeymen through a combination of study and work experience. Apprenticeship programs are specific to particular trades which are

interchangeable across sectors such as "electrician" and "machinist". These apprenticeship programs are important to the industry because the skills developed are transferable across the sectors and certification ensures a consistent technical standard.

Apprenticeship programs could be improved to meet the challenges of a knowledge-based global economy. With the exception of the 40 "Red Seal" programs, apprenticeship standards are different in each province. The Committee believes that efforts should be made to establish national standards which permit apprentices to study for certification and work in different provinces, as job opportunities require, without impediment or penalty. These standards should be expanded into new skill areas for which advanced technology is creating a demand. Career linkages between trade school graduates and industry apprenticeship programs could thus be improved.

The issue of eligibility for apprenticeship programs has become a point of conflict between management and labour in some resource-based industry plants. The Committee has learned that some collective agreements require that eligibility for apprenticeship programs be based upon seniority as well as on entry qualifications. In such a case the junior employee must wait for his or her seniority to build up. This limits the career potential of new trade and technical school graduates and consequently the attractiveness of technical programs. Where such union agreements exist, companies are discouraged from recruiting recent graduates and sponsoring them in apprenticeship programs to build up the technical competence of the firm. As a result of this dispute, some companies have chosen not to sponsor any apprentices.

A seniority requirement for access to apprenticeship programs is an effective restriction on the mobility of workers who may wish to improve their situation by seeking employment elsewhere. The "Employee Training Loan

Scheme" favoured by the Committee will also influence worker mobility since the employee would be obliged to repay some of the training costs to his or her employer when he or she leaves for another job. As was said above however, these residual obligations can be accepted by the new company hiring the worker since it will be gaining the advantages of the training.

In its response to the Prosperity Initiative Reports, NABST strongly supported the establishment of mechanisms to encourage and develop apprenticeship programs and called for the establishment of a National Industry Technology Internship Program. Action on this front is being considered at Canada Employment and Immigration.

RECOMMENDATIONS:

The Committee recognizes that a labour force which is well prepared with a good basic education is a major requirement for a viable and competitive economy. Consequently, the Committee recommends that:

- a) *Canada's primary and secondary educational systems must include a system of national standards which can be used to facilitate a regular evaluation and comparison across the country of the proficiency of our students.*
- b) *Canada Employment and Immigration should have a policy which encourages and promotes technical and trade school programs.*
- c) *the advocacy and promotional programs of the government (ISTC, EMR, Forestry Canada, Environment Canada, NRC), of resource-based companies and of our educational institutions should all emphasize that the development of our natural resources is extremely important for Canada to provide jobs and to maintain its economic*

well-being; that such development need not harm the environment, as it may well have done in the past; and that science and technology are the tools which can be utilized by properly educated people to make this happen.

- d) certification of all apprentices should be based on national standards to eliminate any mobility restrictions of the present system whereby each province has its own licensing standards and apprentices can lose credits when they move from one province to another.*
- e) unions and management should work cooperatively to develop stronger linkages between apprenticeship programs and careers in the industry.*
- f) Canada Employment and Immigration should provide incentives for on-the-job training through programs such as the Employee Training Loan Insurance Scheme.*

5.7 RESEARCH AND DEVELOPMENT AND TAX INCENTIVES

Fair Play on a Level Playing Field

Compared to its competitors, the resource industries sector in Canada invests less in research and development, but that does not mean that there is none being done in Canada or that Canadian firms do not have access to the best of the world's technologies.

A study commissioned by CANMET²¹ found that industrial R&D spending by resource companies in Canada ranked lowest of the eight countries studied. These countries are Canada, Australia, West Germany, Sweden, France, the United States, the United Kingdom and Finland. Canada spent about 0.5% of mining GDP on R&D, compared with 0.7% for Australia and more than 2% for most of the other countries.

Another survey of the research, development, and exploration spending of Canadian mining companies was conducted by the Mining Industry Technology Council of Canada (MITEC) in 1990²². Total R&D expenditures for the studied companies was \$148.6 million in 1990. This represented 0.86% of gross sales of \$17.3 billion. About 90% of R&D in the mining industry is funded by the companies, with the remainder by the federal government.

The forestry industry as a whole spent 0.3% of 1990 sales on R&D. (Fig.13)²³. Statistics Canada data show that the pulp and paper sector and the wood products sector funded \$82 million of R&D in their own laboratories plus an additional \$28.7 million within research institutes. To these amounts should be added some \$20 million of R&D funded by forestry equipment manufacturers in Canada and \$34 million of R&D at Canadair as part of their water bomber program (1988 figures). An estimated \$1 million was funded by industry but performed in university laboratories that year²⁴. In 1990 the logging and forestry industry spent a total of \$10 million on R&D while the wood, paper and allied products manufacturing sector spent \$138 million. Foreign companies tend to conduct the majority of R&D in their home countries; however, their Canadian subsidiaries have access to and benefit from these efforts even though this access is not reflected in the R&D figures of the industry.

Factors which contribute to this low level of R&D expenditure are the commodity nature of the products, and the foreign ownership of several large, integrated companies. Products considered to be commodities traditionally receive lower levels of R&D investment. As value is added, R&D levels increase. The forest products industry compensates somewhat for the low levels of R&D investment through cost effective joint public-private financing for industry-wide R&D by the Pulp and Paper Research Institute of Canada, PAPRICAN, (1990 budget: \$29 million) and by Forintek Canada Corp.(1990 budget: \$14 million).

Although there is a high level of technology already in use in the Canadian resource industries, it is imperative that companies invest larger amounts in R&D. One area where R&D is going to have a great impact in both the mining and forestry sectors is in those technologies which permit more environmentally benign processing. Other important and potentially profitable areas for R&D are new technologies for exploration, processing, and the development of advanced materials in the mining and minerals sector; and continuing development of "engineered wood" products, specialty papers, and bio-technological silviculture in the forest products sector. The industries generally know where they should be investing more in science and technology, but without a competitive investment climate which allows resource companies to return to profitability, they will find it difficult to make these investments.

In Canada, public policies promoting technology and innovation are currently biased away from the needs of the resource industries. The S&T

policies of government are normally focused on four generic support mechanisms: 1. fiscal measures (grants, contracts, repayable loans) supporting product and process development by firms (primarily manufacturers); 2. funding of research in government laboratories for environmental stewardship, health and safety and energy efficiency for the public good; 3. grants in support of more basic, curiosity motivated and some targeted research in the universities; and 4. tax incentives generally available to all firms which conduct qualifying scientific research and experimental development.

Direct grants and contracts selectively target research that is considered important but which is beyond the financial scope of the university, corporation or institute involved. Tax incentives differ from direct financing mechanisms in that they are non-interventional in the choice of R&D activities or the targeting of specific sectors of the economy. A corporation can make its own decision as to why, how and what research is done²⁵.

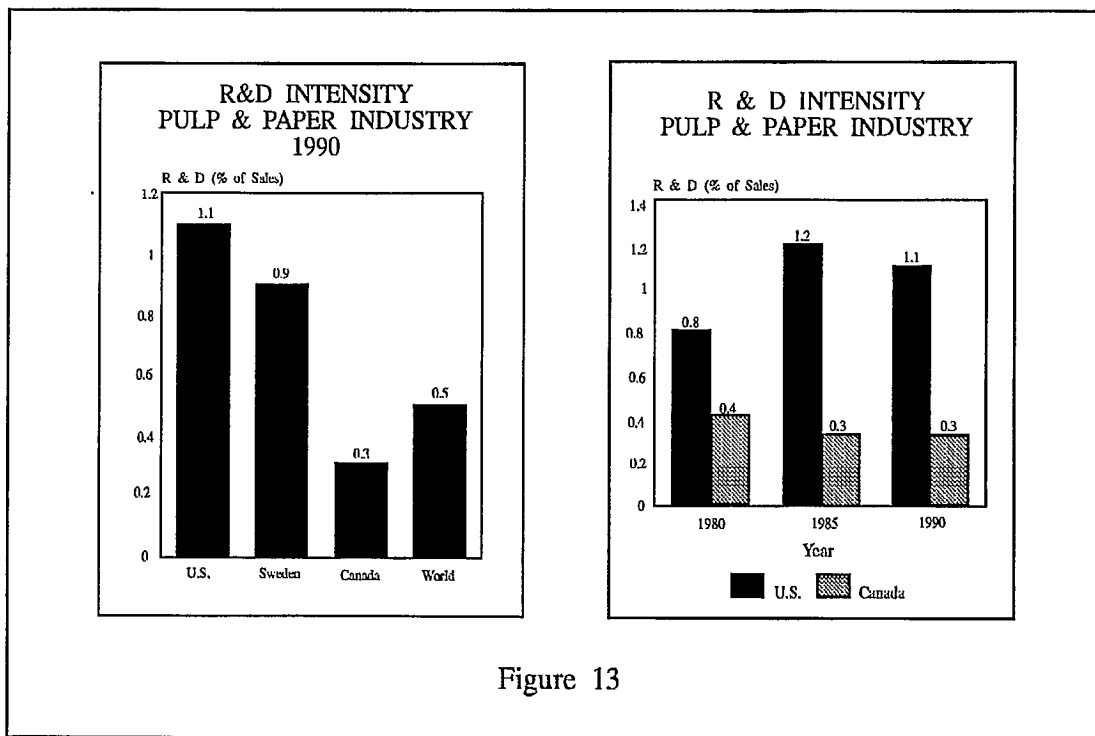


Figure 13

The Scientific Research and Experimental Development (SR&ED) Tax Credit program allows full deductibility of current qualified R&D expenditures and tax credits of between 20% and 30% (depending on the region) which can be applied against federal income tax payable up to 75% of the total. The tax credit portion is refundable to Canadian controlled companies with net incomes not exceeding \$200,000., enabling them to obtain the tax benefits from their R&D investment more quickly.

The definition in the Income Tax act of what constitutes qualifying SR&ED²⁶ is restrictive:

... "scientific research and experimental development" means systematic investigation or search carried out in a field of science or technology by means of experiment or analysis, that is to say,

- (a) basic research, namely, work undertaken for the advancement of scientific knowledge without a specific practical application in view,*
- (b) applied research, namely, work undertaken for the advancement of scientific knowledge with a specific practical application in view, or*
- (c) development, namely, use of the results of basic or applied research for the purpose of creating new, or improving existing, materials, devices, products, or processes,*

and, where such activities are undertaken directly in support of activities described in paragraph (a), (b) or (c), includes activities with respect to engineering or design, operations research, mathematical analysis or computer programming and psychological research, but does not include activities with respect to:

- (d) market research or sales*
- (e) quality control or routine testing of materials, devices or products;*
- (f) research in the social sciences or the humanities;*
- (g) prospecting, exploring or drilling for or producing minerals, petroleum or natural gas;*
- (h) the commercial production of a new or improved material, device or product or the commercial use of a new or improved process;*
- (i) style changes; or*
- (j) routine data collection.*

The interpretation of items (g) and (h) can severely limit research into areas that improve productivity and competitiveness in the resource industries. For example, the "vertical retreat" or "bulk" mining method designed by INCO is a more efficient method of mining; however, in order for the experimental research work to be eligible for R&D tax credits, the ore extracted in the tests cannot be sold. The innovative INCO system was therefore designed and tested without full benefit of R&D tax credits but has proven essential for the competitive position of the firm. More flexibility in the interpretation of the tax act is needed so that tax incentives do encourage the experimental developments which will lead to a more competitive industry.

Revenue Canada R&D guidelines have meant that those firms with special, dedicated facilities and equipment (at least 90%) to carry on research have found it easier to qualify for tax credits. This has tended to result in the separation of research from other corporate activities and is a barrier to the creation of scientifically innovative cultures in corporations. The Committee heard of no instances where corporations increased their research budgets because of the availability of tax credits, but did hear that the restrictive nature of the regulations acts as a disincentive to using the system.

Successful innovating corporations have incorporated R&D into all facets of corporate strategy. This is usually achieved through the advocacy of a "corporate champion", a high ranking executive who sees the value in science and technology to promote corporate goals:

*"Innovation is fostered first by creating a working environment conducive to innovation. It must be fully supported by senior management, with adequate funds made available for research, development and large scale demonstration and implementation."*²⁷

Walter Curlook, Vice-Chairman,
INCO Ltd.
Northern Miner Magazine, Feb. 1992

Creating a "working environment conducive to innovation" means moving R&D out of its cloistered laboratory setting and onto the production floor. Employees work as a team to identify problems and to design and develop solutions. In the traditional corporate organization, R&D is a function of engineering or process technology. Innovative companies have linked R&D to sales and marketing. At Sherritt Gordon (Westaim Technologies), research proposals grow from an initial marketing concept. Throughout the five approval stages, commercialization is one of the benchmarks for evaluation. Other innovators work closely with their customers to develop new products that will enhance their share of the market. (INCO and Cominco with battery manufacturers and end users, Weyerhaeuser with specialty papers and wood products, Alcan with sheet aluminum specifications for container manufacturers, and Cominco with new alloys for bearings with their manufacturers).

Comparisons of R&D spending by Canadian firms to that of their foreign competitors is not always an accurate measure of innovation. Competitiveness cannot be measured solely by the dollars spent on R&D, but is also a function of

"S&T literacy". State-of-the-art technology can often be sourced from the market and adapted to specific applications. The acquisition of proven technology and the development of new technology are both essential elements of a successful competitiveness strategy. It is only through building up in-house expertise and familiarity with the current state of the art, however, that Canadian firms will remain "S&T literate" and will have the capability to incorporate promptly for their own purposes best-practice equipment and procedures which have been developed elsewhere.

Canadian R&D tax incentives are generally considered to be among the most favourable among the developed countries. Recently proposed changes to the Income Tax Act resulting from extensive industry consultations will remove some residual problems in the interpretation and application of the SR&ED tax incentives. These changes will allow corporations to claim partial R&D tax credits for capital equipment that is not exclusively dedicated to R&D and will provide prorated credits for overhead expenditures shared between R&D and production. These improvements should go far to desegregate R&D activities and to promote a closer working relationship between R&D and production/process personnel. As such, these modifications will be addressing to a considerable extent the following recommendations.

RECOMMENDATIONS:

The committee recommends that:

- a) *Revenue Canada, Taxation should interpret the definition of R&D for the purpose of tax benefits at least as favourably as other jurisdictions with respect to value-added development, incremental process development and quality control.*
- b) *the Department of Finance should extend the eligibility for R&D tax credits to cover the cost of equipment which is used part of the*

time for special tests to develop new processes or technologies. In such cases firms would be required to maintain clear cost segregation data between production use and R&D use.

c) the research and development done on the shop floor and in production facilities should be allowable for R&D tax incentives, prorated to the amount of effort which is incremental to ongoing production.

6. CONCLUSIONS

Through the processes of consultation and deliberation, the Committee found that the resource industries of Canada have been and continue to be major and sustaining pillars of the Canadian economy, particularly in many of Canada's more remote regions. We have found that the industry as a whole has been striving to adapt and adjust to rapidly changing competitive conditions throughout the world. They are not the archetypical "hewers of wood and diggers of ore" which is the image held by too many of their compatriots, especially in urban Canada. They are among the most intensive users of advanced technological equipment in Canada. In many ways the resource industries should be counted among the "high tech" industries.

Industrial representatives believe there is a considerable body of opinion which would write off resource companies as yesterday's industry, doomed to wither as lower cost resources and lower wages in the third world eliminate their traditional advantages. While it is true that the resource industries of Canada are under unprecedented competitive pressure, the Committee is convinced that they remain a vital part of our economic fabric and a real asset for Canada within the global marketplace. How many countries without Canada's natural resource assets, and who are forced to import much of their minerals, energy supplies and food, would be willing to change places with us?

These other nations, in order to compensate for their lack of indigenous natural resources (Japan), or to compensate for higher cost feedstock (the Scandinavian countries), have invested more heavily than Canada in research and development and in those downstream products and industries which rely more on intellectual than natural resources. They have no unique advantage in the pursuit of this strategy. Canada too has the ability to open new opportunities based upon the creativity and innovative spirit of our researchers,

workers and managers. In order to be competitive, the resource industries of Canada need to invest more in longer term research and development in the technological areas which are shaping their competitive environments.

Canadian resource industries are working within an investment climate which is less attractive than it used to be in Canada and which has lost ground against that of other countries. There is an urgent need for the government, in concert with industry, to establish those investment, incentive and environmental policies which will allow the resource industries of Canada to compete effectively in world markets on a more level playing field.

The further challenge for all of Canada, not just its resource industries, is to develop a healthy balance in the development of all of our resources, both natural and intellectual. The members of this committee believe that we can build upon the traditional economic strengths of our natural resources while adding to it the power of downstream development and the dynamism of the new "knowledge industries" of the service sector.

APPENDIX A

RECOMMENDATIONS

1. SUSTAINING AND EXPANDING THE RESOURCE BASE

The Committee recommends that:

- a) because the non-ferrous metals industry is in a crisis, the Department of Finance should promote investment in mineral exploration through tax or other incentives which help to make Canada as attractive for exploration expenditures as other countries. These incentives should specifically target those base metals whose reserves are in decline.*
- b) ISTC, EMR and Investment Canada, in cooperation with provincial governments, should benchmark the Canadian investment climate (including investment, environmental, incentive, and other policies) against those of other countries such as Mexico, Chile and Bolivia for the mining and minerals industry; and Scandinavia, the United States and South American countries for the forestry industry; to determine whether the Canadian investment climate is competitive and what policy adjustments could be made in order to attract more exploration and development investment to Canada.*
- c) resource industries in the mining and minerals sector should collaborate in exploration technology R&D programs with government (EMR and the National Research Council (NRC)) and university laboratories, where market potential can be identified and where the direction and at least some of the funding is provided by industry.*
- d) EMR should allocate a higher percentage of its laboratory resources to exploration technology research.*
- e) forestry and forest product firms should establish collaborative co-funded research programs with the Department of Forestry, provincial departments of Natural Resources and universities and colleges to develop the technology to achieve a better yield of wood and fibre from land that is allocated to forestry.*
- f) the Forestry Research Advisory Council of Canada (FRACC) should be given more authority over the selection and direction of the research programs being undertaken by that department. Both the FRACC and the Minister's Advisory Council on CANMET (MNACC) should provide their annual reports to industrial firms and to their associations in order to increase awareness of the work of the government's labs and to encourage more collaboration.*
- g) ISTC should improve assistance services and programs which encourage research collaboration between resource companies and government and university researchers.*

2. ENVIRONMENTAL REGULATION

The Committee recommends that:

- a) *the Department of the Environment and provincial departments responsible for environmental matters should jointly and urgently address the problem of overlapping and conflicting jurisdiction over environmental standards, regulation and enforcement.*
- b) *federal and provincial departments responsible for environmental matters should come to an early agreement on national environmental standards, together with accompanying regulations, and that, where possible, the enforcement of these regulations and standards should be the prime responsibility of only one level of government.*
- c) *the impact on the economic competitiveness of a project or an industry should always be included and considered as a factor of major importance in the evaluation by relevant authorities of any environmental regulation or permitting process.*
- d) *government laboratories should continue to perform research for the public good which assists in the establishment of well-founded policies and regulations to protect the health and safety of Canadians and the Canadian and world environment. In this work they should consult and collaborate with industry to be more aware of the economic impact of potential regulations.*

3. THE VALUE-ADDED PRESCRIPTION

The Committee recommends that:

- a) *the Department of Finance and Investment Canada should work to establish an attractive and competitive investment climate in Canada to encourage investment in the basic resource industries, and do everything they can to provide a stable environment for the development of these industries which are considered to be of prime importance for the continuing wealth of Canada.*
- b) *government support should be directed only at those firms and operations which are of a scale and quality to be internationally competitive and not at sub-marginal and inefficient plants.*
- c) *ISTC should work with the Department of Finance, EMR and Forestry Canada to establish effective policies to encourage resource companies to forward integrate into value-added specialty products where market conditions are favourable.*
- d) *ISTC, working with EMR, Forestry Canada and NRC, should design and implement policies to encourage the development and growth of secondary manufacturing companies which create value-added products based upon Canadian resources.*
- e) *resource companies should collaborate with Canadian secondary manufacturers determining how to add greater value to their materials and should work with their domestic customers to develop new competitive downstream uses and value-added products derived from resource materials.*

- f) *resource companies should collaborate with and provide direction and funding to the research programs of the laboratories of EMR, Forestry Canada and NRC so that these are applied in a more balanced way to both upstream and downstream technology development, supporting exploration, extraction, transportation, upgrading, refining and subsequent product development, where there is identified market potential.*
- g) *the laboratories of the federal government should be more proactive in assisting both resource and manufacturing companies in Canada to develop the industrial processes and products which will maximize the economic returns to Canada from the development of our natural resources, while minimizing disruption to the environment.*

4. UNIVERSITIES AND OTHER POST SECONDARY INSTITUTIONS

The Committee recommends that:

- a) *universities should collaborate with each other and with industry to assure that resource-related research programs are focused with a view to the achievement of world class stature, and that research programs are not duplicated across different institutions.*
- b) *performance rating and promotion of staff in educational institutions should include credit for work done by professors on behalf of or in collaboration with industry partners.*
- c) *industry-led Advisory Boards should have budgeting authority in programs designed to support interaction between educational institutions and industry; that industry should have input into policies and directions of longer term research; and that industry personnel should be included in the review and selection process for entrepreneurial research projects within educational institutions which are intended to enhance Canada's competitiveness.*

5. GOVERNMENT AND INDUSTRIAL LABORATORIES

The Committee endorses the recommendations of the NABST report on Federal Science & Technology Expenditures (Lortie:1990) that each government laboratory should have:

- a) *Institute Status - that it be autonomous with its own board of directors and its own chief executive officer, who would be responsible for the operations of the laboratory.*
- b) *A Contractual Relationship - the laboratory should enter into specific contracts with the department which it serves. The contracts would spell out clearly what services are to be supplied by the laboratory as well as the fees to be paid for these services.*
- c) *A Revenue Dependency Funding Relationship - the laboratory would be paid in a business-like manner for the work it does either by the government department it serves or by industry which would also be encouraged to contract with the laboratory for execution of specific projects.*

- d) *A Management Structure - as an autonomous entity, the laboratory would be able to enter into contracts, would be responsible to perform in a satisfactory manner in order to retain its clients, and would be able to retain the earnings generated by its services, to be used as its officers determined to be most beneficial for the laboratory.*
- e) *An Evaluation Regime - the board of directors and chief executive officer would also have the responsibility and authority to evaluate the quality of personnel in a recognized manner in order to guarantee the highest standards of excellence at all times.*

In connection with item a) above, the Committee further recommends that the board of directors of such an institute comprise, at least partly, independent senior staff members recruited from the industries the institute would normally serve.

6. HUMAN RESOURCES

The Committee recognizes that a labour force which is well prepared with a good basic education is a major requirement for a viable and competitive economy. Consequently, the Committee recommends that:

- a) *Canada's primary and secondary educational systems must include a system of national standards which can be used to facilitate a regular evaluation and comparison across the country of the proficiency of our students.*
- b) *Canada Employment and Immigration should have a policy which encourages and promotes technical and trade school programs.*
- c) *the advocacy and promotional programs of the government (ISTC, EMR, Forestry Canada, Environment Canada, NRC), of resource-based companies and of our educational institutions should all emphasize that the development of our natural resources is extremely important for Canada to provide jobs and to maintain its economic well-being; that such development need not harm the environment, as it may well have done in the past; and that science and technology are the tools which can be utilized by properly educated people to make this happen.*
- d) *certification of all apprentices should be based on national standards to eliminate any mobility restrictions of the present system whereby each province has its own licensing standards and apprentices can lose credits when they move from one province to another.*
- e) *unions and management should work cooperatively to develop stronger linkages between apprenticeship programs and careers in the industry.*
- f) *Canada Employment and Immigration should provide incentives for on-the-job training through programs such as the Employee Training Loan Insurance Scheme.*

7. RESEARCH AND DEVELOPMENT AND TAX INCENTIVES

The committee recommends that:

- a) *Revenue Canada, Taxation should interpret the definition of R&D for the purpose of tax benefits at least as favourably as other jurisdictions with respect to value-added development, incremental process development and quality control.*
- b) *the Department of Finance should extend the eligibility for R&D tax credits to cover the cost of equipment which is used part of the time for special tests to develop new processes or technologies. In such cases firms would be required to maintain clear cost segregation data between production use and R&D use.*
- c) *the research and development done on the shop floor and in production facilities should be allowable for R&D tax incentives, prorated to the amount of effort which is incremental to ongoing production.*

APPENDIX B

REFERENCE

1. D'Cruz, Joseph and Rugman, Alan, *New Compacts for Canadian Competitiveness*, University of Toronto, March, 1992
2. Porter, Michael, *Canada at the Crossroads*, The reality of a new competitive environment, Study for BCNI and ISTC, 1991
3. Prospectors and Developers Association (PDA) presentation at Mines Ministers Conference in September 1991
4. Statistics Canada, *Canada Year Book 1990*, Minister of Supply and Services Canada, 1991
5. *The Market Pulp Industry 1986-1990*, Forest Sector Advisory Council
6. *The Canadian Mineral Industry in a Competitive World*, Report of the Intergovernmental Working Group (IGWIG) on the Mineral Industry, September 1992
7. Cranstone, Donald A., *Canadian Base Metal Reserves, 1980-1990: Today's Exploration Challenge*, Mineral Policy Branch, Energy Mines Resources; Ottawa: 1991
8. *The Canadian Nonferrous-Metals Sector*, Science Council Sectoral Technology Strategy Reports #8
9. Total Exploration Expenditures By Junior and Senior Companies 1969-92 From IGWIG, *Canada's Mineral Industry and the Global Competitiveness Climate*. pp.57
10. Cranstone, Donald A., *The Canadian Mineral Discovery Experience Since World War II*, pp. 295 Rate of Return on Exploration Expenditure, EMR, Mineral Policy Branch 1988
11. R.M. Newnham, *Forest Management in Canada: Summary*, F.L.C. Reed and Ass. Ltd., Forest Management Institute, Information Report FMR-X-102, February 1978, p. 47
12. Environment Canada, *A Forest Sector Strategy for Canada*, Canadian Forestry Service, Ottawa, 1981, p. 14.
13. Hagner, Stig O.A., "Forest Management under New Conditions: What has Been Done in Scandinavia?", *The Forest Imperative*, Proceedings of the Canadian Forest Congress, Toronto, September 1980, p. 43.
14. Mines Minister's Conference #1, Mining and the Environment, September, 1991
15. *The Need for Canada to Change Course*, Report on Science and Technology, Innovation and National Prosperity, 1991, National Advisory Board on Science and Technology

16. *The Canadian Forest-Products*, Sector Science Council Sectoral Technology Strategy Reports #9
17. *Canadian Minerals and Metals Industry, Trends and Short Term Outlook, Canadian Base Metal Price Index 1971-1991*, EMR, p.75
18. *Report on Federal Science and Technology Expenditures*, National Advisory Board on Science and Technology, 1990
19. Sector Reports prepared by the Canadian Mining Association and the Forest Sector Advisory Council for the Prosperity Initiative
20. *A Lot to Learn*, Economic Council of Canada, 1992
21. Wojciechowski, Margot, *Research and Development in the Mineral Sector*, Kingston Ontario, Centre for Resource studies, 1989
22. Survey of the research, development, and exploration spending of Canadian mining companies conducted by the Mining Industry Technology Council of Canada (MITEC) in 1990.
23. Industrial Research and Development; Statistics Canada (catalogue 88-202)
24. Holbrook, JAD, Private communication, ISTC S&T Economic Analysis Division
25. Madore, *Research and Development Tax Policy*, The Library of Parliament, 1989
26. The Income Tax Act, Subsection 2900(1) of the Income Tax Regulations
27. Curlook, Walter, Vice-Chairman, INCO Ltd. Northern Miner Magazine, February 1992
28. *Survey of Diffusion of Technology in the Mining Industry*, June 1990, Report published jointly by ISTC, CANMET, Communications Canada and Statistics Canada

APPENDIX C

ACKNOWLEDGEMENTS

The Committee wishes to thank the numerous persons who have assisted us in conducting our investigation of competitiveness strategies for the resource industries. Specifically:

Mr. O.K. Ashim
Director, Customer Service
Weyerhaeuser Canada, Saskatchewan Division

Dr. Malcolm Bell
Vice President, Technology
INCO Limited

Dr. Thomas Burnett
Director of Government Affairs
INCO Limited

Dr. Walter Curlook
Vice-Chairman
INCO Limited

Mr. R. B. Findlay
President and Chief Operating Officer
MacMillan Bloedel Limited

Dr. O.L. Forgas
Senior Vice-President, Research & Development
MacMillan Bloedel Limited

Mr. Clive Gildea
Technical Manager, Papermill
Weyerhaeuser Canada, Saskatchewan Division

Dr. James W. Gill
President
Aur Resources Inc.

Mr. Keith Hendrick
Chairman
Noranda Minerals Inc.
and
Chairman, Mining Association of Canada 1991-92

Mrs. Janet E. Halliwell
Chairman
Science Council of Canada

Dr. W. G. Jeffrey
Executive Director
Mining Industry Technology Council of Canada (MITEC)

Dr. Frank L. Lederman
Senior Vice-President, Technology
Noranda Inc.

Mr. David L. McInnes
President and Chief Executive Officer
Weyerhaeuser Canada Ltd.

Mr. George Miller
President
Mining Association of Canada

Mr. G. W. Moore
Vice President, Technical Services
Potash Corporation of Saskatchewan

Mr. Anthony J. Petrina
President and Chief Executive Officer
Placer Dome Inc.
and
Chairman, Mining Association of Canada, 1992-93

Mr. George Petty
Chairman and Chief Executive Officer
Repap Enterprises and
Co-Chairman, Forest Sector Advisory Committee

Dr. Graeme Strathdee
Director, Research and Development
Potash Corporation of Saskatchewan

Mr. John Valley
Forest Industries Action Group
Ontario Ministry of Natural Resources

Dr. Robert Weir
Vice President, Technology
Sherritt Gordon Limited
and
President
Westaim Technologies

Dr. John Wilson
Vice-President, Research & Development and Technology
Alcan International

Mr. Bill Robertson
Vice President, Mine Operations
Cominco Limited
Mrs. Margo Wojciechowski
Executive Director
Centre for Resource Studies
Queens University

Mr. Roy Woodbridge
President
Canadian Advanced Technology Association

Mr. M.S.J. Woolley
Manager, Earth Sciences
Potash Corporation of Saskatchewan

Mr. Adam Zimmerman
Chairman and Chief Executive Officer
Noranda Forest Inc.

The Committee would also like to thank numerous government officials from the Department of Energy, Mines and Resources, Forestry Canada and Industry, Science and Technology Canada. Any errors or omissions, however, are the responsibility of the Committee and not those who assisted us through the provision of information and statistics for use in the report.