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When one tackles the subject of innovation, one is forced to confront a myriad of complex, interconnected and pervasive issues.

All governments are now grappling with the question of their role in innovation. This has been particularly true for the Canadian government in the 1980s. Our sense of urgency in addressing these issues is increasing. National borders do not make a country immune to what is truly a "global" phenomenon. The very nature and scope of the innovation challenge has made a re-examination of roles and relationships among all of the stakeholders imperative, whether they are in the government, business or science communities.

The technologies of the post-World War II era are being replaced, or at least augmented, by a new set with a "Japan Inc." trademark in the forefront. We have seen a revolution in microelectronics, based on the marriage between computer and telecommunications technology — the "information revolution." We have also seen the emergence of biotechnology and advanced materials — technologies which will increasingly underlie industrial competitiveness. This has changed both markets, and historical relationships between countries. The information revolution has made the globalization of manufacturing possible, and recently the globalization of some services as well. Competition in certain products is now taking place on a global scale.

This has changed not only the whole approach that business must take to competition, but also governments' approach to providing a positive climate for economic growth and development. Being a successful competitor today, whether a business or a country, means being able to deal with change effectively, One of the keys to success in accommodating change, is more open dialogue between governments and private sector stakeholders, publicly and in forums such as this Conference.

To provide you with a Canadian perspective on the role of government in this time of rapid change, I want to first give you an idea of Canada's past experiences; then discuss some of the challenges we face; and finally describe briefly how the role of government in supporting innovation is changing in Canada.

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I. THE CANADIAN EXPERIENCE

In Canada, the federal government has always played an important role in science and technology. What has changed over the years is the nature of that role, and its relationship to innovation in the private sector.

The emphasis in the past was on basic research, and on ensuring that Canada had a healthy science infrastructure. Characteristic of the Canadian government's early involvement was the creation of the National Research Council ("NRC"), which has taken the lead for the past sixty years in actually performing scientific research. Other federal departments such as National Health and Welfare, Environment, Agriculture, Fisheries, Energy, Mines and Resources, and Communications also developed substantial research programs and facilities not only to support their health, safety and other regulatory responsibilities, but also to carry out basic research in these sectors.

Through the 1970s and early 1980s, much of the public policy concern with innovation centered on funding the universities to ensure an adequate supply of highly qualified personnel. Granting councils, along the lines of the U.S. National Science Foundation and the National Institutes of Health in Canada, were established. Today, the Natural Sciences and Engineering Research Council, the Medical Research Council and the Social Sciences and Humanities Research Council play a significant role in supporting the science and technology effort in Canadian universities.

Since World War II, Canada's basic science infrastructure has matured substantially. Although continuing improvements are needed, a significant shift is occurring in public policy priorities. There is a growing concern that Canada's industrial research and development, and capacity to innovate, are inadequate to the new technological challenges of the 21st century. This concern is, in turn, reflected increasingly in the activities of government.

For example, the NRC has assumed new roles related to applied research and to assisting small businesses with their technology problems. The Council has placed increasing emphasis on its Industrial Research Assistance Program ("IRAP"). IRAP is an outreach program that is aimed at increasing the caliber and scope of applied industrial research and development through use of the latest available technology. It assists Canadian companies by putting into their hands the scientific and research and development management resources of the federal government and other research organizations.

The NRC has been involved in a number of innovations that have had important commercial results. In 1987, for example, surgeons from the University of Ottawa's Heart Institute used an NRC fiber optic system in the world's first laser procedure designed to clear plaque deposits from coronary arteries. The ultraviolet laser used in this operation was

developed by Lumonics Inc. of Ottawa, with NRC technical and financial assistance.

Another example is in the area of superconductivity. The NRC played a key role in identifying the crystalline structure of some of the more promising superconducting materials, and is now working with Canadian companies in this field.

Other federal government laboratories are increasingly entering into research and development alliances with private firms or contracting out mission-oriented research in support of their mandates. The objective is to increase both the market relevance of the government's substantial research and development spending, now amounting to some $4 billion annually, and to upgrade private sector capabilities in new areas of science and technology.

II. Problem Definition: Canada's Challenge

The relatively low level of research and development performed in Canada, particularly in the industrial sector, is a major concern. Although it is a crude measurement, the share of economic output devoted to the performance of research and development in Canada is around 1.4%. This figure lags behind our main Organization for Economic Cooperation and Development ("OECD") trading partners, the United States, Japan, France and the Netherlands — all spending between two and three percent of gross domestic product ("GDP") on research and development over the last seven or eight years. Canada also ranks behind Norway, Finland and Sweden, which are small countries where natural resources are an important part of GDP, as they are in Canada. Of course, a major explanation for this gap between the Canadian and U.S. levels is the quantum difference in defense-related research and development performed in our two countries. However, there are also three other key factors which help explain the relatively lower level of research and development spending in Canada.

First, there is the structure of the economy, particularly the importance of resource-based industries. Canada's rich endowment of natural resources has traditionally been our bread and butter. It has always been, and to a lesser extent continues to be, the engine of our economic growth. Technology and innovation are, of course, important to the resource sectors. However, the fact is that they are substantially less research and development intensive than manufacturing, which constitutes a lower proportion of total Canadian economic activity than in other G-7 countries.

A second factor, and another historical reality for Canada, is the high level of foreign ownership in the Canadian economy. With some notable exceptions, multinational corporations have typically concentrated research and development in their home countries, usually the United States. This has reduced the extent of these activities carried on

in Canadian subsidiaries. Some parent companies have given their Canadian affiliates world product mandates in certain product lines, thus stimulating innovation and research and development in the affiliate, but this has been more the exception than the rule.

Finally, Canada's relatively small population scattered across its vast geography has tended to weaken the environment for innovation. The physical dispersion of intellectual and physical resources has made it difficult for critical masses of scientists, engineers and entrepreneurs to coalesce effectively.

A factor which pervades many aspects of public policy in Canada, including innovation, is the importance of the provincial and territorial governments. The provinces have jurisdiction over the natural resources within their borders, so many of their technology programs focus on resources and the environment. Oil-rich Alberta has an extensive series of programs in coal and oil research including enhanced oil recovery. Nova Scotia has programs in mineral and energy research and innovation. In addition, primary and secondary education in Canada is strictly a provincial responsibility so that we depend on the provinces for the improvements needed in basic literacy and science skills.

Thus, although Canada is confronted by many of the same competitive challenges that face the United States and other developed nations, there are also a few challenges which are unique to Canada.

III. Canadian Government's Response

The climate for innovation is changing. It is not only the fact of change that has caught our attention, it is the pace. What we are experiencing today is formidable and unprecedented and poses a real challenge for decision-makers in industry and government.

To meet this challenge, the Canadian government has moved to forge a national consensus on the importance of ideas and innovation, science and technology for our economic well-being. It has proceeded in partnership with the business and science communities and the general public in developing a national innovation agenda. It is noteworthy that the substantial progress toward this objective has taken place at a time when Canadian economic growth, stimulated largely by exports of traditional resource products was second only to Japan among OECD countries.

In February 1987, the Prime Minister chaired the first meeting of the National Advisory Board on Science and Technology ("NABST"), made up of thirty-five eminent Canadian industrialists, entrepreneurs, academics and labor leaders. NABST is a means of bringing advice to the highest levels of the federal government from the most senior representatives of business, the academic community and the labor movement. Some of the issues upon which it has offered advice have included: university-industry relations; increasing the role of industrial innovation and

investment in new technologies; the participation of women in science and technology; and ways of improving the management of federal science and technology expenditures. Six provinces have also established high level advisory councils.

To further extend the national dialogue on a strategy for innovation, the federal government sponsored a National Conference on Technology and Innovation in January of 1988. The conference brought together some 200 CEOs, university presidents and senior government officials who spent two and a half days in workshops discussing how to make Canada a more innovative and technologically proficient country.

The consensus reached at the Toronto conference has been confirmed by NABST and the provincial advisory councils. It is also consistent with the National Science and Technology Policy which the federal and provincial governments have adopted to promote complementarity between the activities of the two levels of government.

The Toronto conference identified the federal government as both a problem and problem-solver. Government was encouraged to use procurement better to help small high-tech firms, update intellectual property laws, improve technology transfer to industry from federal laboratories, increase funding for university research and so on.

However, the consensus also identified other stakeholders with essential roles to play. It observed that: industry had not been putting enough effort into research and development; there was a need for more "technology champions" and more technological literacy at the corporate executive level; it was not only or necessarily more industrial research and development that was needed, but mere effective acquisition and use of best practice technology already existing or which would be developed elsewhere; innovation, human-resource development and long-term technology forecasting should be integrated into corporate strategies; business and labor should work together to manage technological change; and a more science and engineering oriented culture was needed in Canada.

What has been the response? The need for long-term strategic thinking on the part of business is becoming more widely accepted and applied. A number of Canadian firms have begun to take a closer look at their technology needs. This should lead to a greater commitment on the part of Canadian industry to the long-term applied research that is essential to provide the basis for continued competitiveness in the future.

A key element of the federal government's response has been the creation of a new department, Industry, Science and Technology ("ISTC"), which brings together the science and technology policy and industry policy functions of the federal government. ISTC has a mandate for national leadership towards two key objectives: an internationally competitive Canadian industry, and science and business excellence.

On the threshold of the 21st century, the goal is to maintain Canada's position in the front rank of industrial nations.

Among ISTC's top priorities are stimulating industry capabilities in new technologies; acting as a catalyst in assembling a critical mass of university and private sector researchers and projects; and facilitating more effective acquisition and use of technology throughout industry.

In carrying out its mandate, ISTC is emphasizing pre-competitive stages of the innovation process — generic, applied research, for example — and other measures to improve industrial competitiveness. These include the provision of up-to-date information on the international competitive environment, and of services designed to assist firms in strengthening their strategic planning.

There are two major new activities which exemplify the new Department's approach to its mandate. The first is the Networks of Centres of Excellence in the sciences, which will help develop synergies among researchers dispersed geographically in laboratories all across Canada. The second involves strategic technology initiatives to promote the formation of alliances of companies to conduct pre-competitive research and development, or to undertake the pre-commercial application of leading-edge technology in three strategic areas of economic importance: information technology, biotechnology and advanced industrial materials. It is important to note that there is a provision for support to alliances which also involve U.S. or other foreign partners.

An important model for these activities was the formation, in 1983, of our National Biotechnology Strategy. The purpose of the strategy was to build the scientific and technological infrastructure and to promote the training of highly qualified personnel in the biological sciences. There have been excellent results: the biotechnology industry in Canada has grown from a handful before 1983 to over 200 companies today. A similar initiative in the field of advanced industrial materials is in progress.

Past incarnations of the "industry department" have dealt mainly with particular firms and their innovation or modernization problems on a case specific basis. ISTC will aim more broadly at industry sectors where it will act in a catalytic way to bring the stakeholders to the table to agree on a joint action program to address specific competitiveness challenges.

This is not to say that the government's innovation thrust is uniquely the province of the Department of Industry, Science and Technology, or of other science and technology oriented government departments and agencies. Obviously the way competition policy deals with the new kinds of strategic technology alliances which are emerging among firms in Canada and elsewhere will be critical. Similarly, intellectual property protection in the new technologies is a key consideration in providing a positive environment for new investment. The increased pro-

tection for pharmaceutical patents adopted eighteen months ago is one example of our determination in this regard.

Other regulatory functions of government also need to be modernized to reflect demands of the new technologies. A good current example is the national effort which my department is leading to bring together the main departments responsible for health, safety and environmental regulation of new biotechnological products. The need for a well-defined regulatory framework for these products was the top priority identified in the recent report of the National Biotechnology Advisory Council, the private sector driver of the National Strategy referred to above.

Another important instrument which governments can use to support innovation is public sector procurement. In the United States, defense-related procurement has been among the most important instruments for stimulating the development of new technology. In Canada, the defense and civilian procurement effort is much smaller than that in the United States, however, Canada is now engaged in strenuous new efforts to find ways of using the procurement budget more systematically to help foster innovation. For example, a federal government contract for the flight simulator on the CF-100 aircraft and contracts for other military aircraft simulators have greatly contributed to the emergence of CAE Electronics as a world leader in the development and production of commercial and military flight simulators. Similarly, Canadian Astronautics Ltd. has become a significant Canadian and international supplier for space instruments and satellite components as a result of a series of small research and development contracts and a follow-up production contract from the federal government.

Probably the most pervasive governmental artifact determining the climate for innovation is the tax system. Traditionally, generous capital cost allowances in corporate taxation have stimulated vigorous capital investment in resource-related sectors. Thus, the Canadian steel and petrochemical facilities, petroleum industry installations and mining operations have consistently been among the most modern and competitive in the world. More recently, after some experimentation, we have developed a system of research and development tax incentives which are among the most generous of the OECD countries.

Nevertheless, technological innovation has become far more complex than making investments in capital assets. The innovation challenge is only beginning to be understood, much less addressed, by all of the governmental, business and academic players. Sustained efforts to understand the dynamics of technological change and to achieve "alignment" among the stakeholders demands vigorous national leadership in all of these communities for the foreseeable future.

In conclusion, I could not talk to this audience about the role of governments in innovation without mentioning international trade rules. The traditional tariff walls which have protected Canadian manufacturers for a century are crumbling at an accelerating pace. Successive Dil-

lon, Kennedy, Tokyo and now Uruguay rounds of multilateral trade negotiations have set the tone.

The need to be internationally competitive has taken on a new meaning for Canadians with the conclusion of a Free Trade Agreement ("FTA") between our two nations. The FTA is, in a sense, the ultimate means our respective governments have to encourage innovation.

One effect of the FTA has been a heightened sense of cooperation among academics on both sides of the border. ISTC is currently undertaking a major feasibility study of a high-speed broadband communications research network that would link Canadian universities across the country. While there are already numerous regional networks, a national network would provide the opportunity to link Canadian universities more effectively with each other, and with their counterparts here in the United States.

This renewed spirit of cooperation comes at an opportune time, as both countries face major challenges whose resolution will in many cases have an important science and technology component. Not the least of these are a mounting number of environmental problems including acid rain, the ozone layer, the greenhouse effect and the disposal of chemical and nuclear wastes. In addition, both countries are trying to come to grips with the fact that their regulatory regimes tend to lag behind the reality of technological change. In biotechnology, for example, the Canadian Department of Agriculture is already cooperating with the U.S. Food and Drug Administration.

In short, the FTA provides excellent opportunities to build upon what has been a very successful working relationship in technology and innovation. It is a relationship which is envied by other nations and one that has served the interests of both of our nations well in the past. Furthermore, it is a valuable asset which will allow both Canada and the United States to successfully meet the challenges of the future.