

INNOVATION

***The Canadian Strategy
for Science
and Technology***



Ministry of State

Science and Technology
Canada

Ministère d'État

Sciences et Technologie
Canada

Canada

A Word from the Minister of State for Science and Technology

The speech from the Throne last October affirmed the government's commitment to science and technology as key forces in Canada's economic renewal and called for a federal Science and Technology Strategy to ensure that government leadership provides the strategy Canada needs to bring science and technology to the centre of the government's agenda.

InnovAction

The Canadian Strategy for Science and Technology

InnovAction provides that focus and direction. It strengthens the key areas where our performance is weak, and builds on the areas where we are strong. It will encourage private sector development and keep with us the scientific and technological talent that we need to become a truly innovative, competitive, world-class nation, able to survive and succeed in today's marketplace. It will help us meet our role and a better standard of living for Canadians in the future.

InnovAction is above all a call to action and a new sense of partnership. Earlier this month the federal, provincial and territorial governments set a new course for regional development and innovation in Canada, signing Canada's first National Science and Technology Policy.

A Word from the Minister of State for Science and Technology

The Speech from the Throne last October underlined the government's commitment to science and technology as key forces in Canada's economic renewal, and called for a Federal Science and Technology Strategy to support that commitment. **InnovAction** provides the strategy Canada needs. It brings science and technology to the centre of the government's agenda.

InnovAction is a vital first step in shaping the economy of the future, where Canadian industries must compete with the best in the world.

InnovAction is a vital first step in shaping the economy of the future, where Canadian industries must compete with the best in the world. Never before has our ability to compete internationally been so closely tied to our ability to harness science and technology for industrial innovation.

Canada is part of the global race for technological survival. Consultations with the provinces, universities, business and labour have made one thing very clear: we must act now to give focus and direction to our efforts in science and technology.

InnovAction provides that focus and direction. It strengthens the key areas where our performance is weak, and builds on the areas where we are strong. It will help Canada attract, develop and keep world-class scientists and engineers. It will help business and industry develop competitive, world-class technologies to survive and succeed in today's marketplace. It will help secure new jobs and a better standard of living for Canadians in the future.

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The stakes are high. Future jobs and future prosperity depend on our scientific and technological resources. I am convinced Canadians have the intellectual capital and the innovative drive to meet the challenge.

That policy pays particular attention to the application of science and technology to Canada's regional development, based on provincial and territorial priorities. By strengthening the country's regional capabilities in research, development and innovation (e.g. in the resource industries and in the creation of new business in manufacturing and services) national performance in science and technology will be greatly enhanced. In the spirit of that agreement, **InnovAction** provides the strategic framework for cooperative action — and cooperation is the key to success.

The stakes are high. Future jobs and future prosperity depend on our scientific and technological resources. And I am convinced that Canadians have the intellectual capital and the innovative drive to meet the challenge by achieving a degree of technological excellence unsurpassed in the world. **InnovAction** is a solid step forward in that direction.

Frank Oberle

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Overview

Today's technologies are creating a second industrial revolution, where science and technology determine economic prosperity more than ever before.

Today's technologies are creating a second "industrial revolution", where science and technology determine economic prosperity more than ever before. Every day advances in science and technology change the way we do business, creating new products, new services, and new jobs. And with each advance, nations face a new challenge — to improve productivity and gain a competitive edge over world competitors.

Many countries are responding with intensive, carefully planned programs to spur scientific research and the diffusion of technologies in their industries. Focusing on key "strategic" technologies such as biotechnology and microelectronics, they are developing the tools to automate faster, produce goods more cheaply, and stay at the forefront of the technological revolution.

Canada can not afford to fall behind. Despite significant achievements, our performance in science and technology has been weak in many areas. Science and technology has not been a national priority. The infrastructure to support technological development in our industries must be made stronger. Canadians generally have not fully understood the social and economic importance of science and technology.

But things are changing. Private investment in research and development has increased dramatically in recent years. Initiatives such as the federal Space Program are stimulating new efforts at the cutting edge of technological development. And with the new National Science and Technology Policy, federal, provincial and territorial governments have signalled a clear commitment to research, development and innovation in Canada.

InnovAction builds on this momentum with a practical, coherent federal agenda for innovative action. It focuses science and technology efforts in five critical areas:

Industrial innovation and technology diffusion

To improve the transfer and commercial application of new technologies and achieve a maximum return on research investment, **InnovAction** strives to enhance government-industry-university cooperation, and post-R&D innovation.

Strategic technologies relevant to Canada

To broaden Canada's industrial base, **InnovAction** will help industries identify and secure economically exploitable niches in leading edge technologies.

Effective management of federal resources

To foster in-house excellence and create a climate for increased investment in the private sector, **InnovAction** ensures the effective management of the government's annual \$4 billion investment in science and technology.

Human resources for science and technology

InnovAction will help maintain a supply of highly qualified scientists, engineers, technologists and technicians, encourage retraining when needed and facilitate adjustment to technological change in the work place.

Public awareness of science and technology

To help create the social environment needed for a strong, national science and technology effort, **InnovAction** will promote technological literacy and a more science-oriented culture.

InnovAction will help industry develop world-class technologies, and help Canada respond to the international competitive challenge.

With these five components, **InnovAction** identifies critical areas of action. The Strategy establishes a comprehensive agenda for science and technology — helping industry develop and apply world-class technologies, and helping Canada respond to the international competitive challenge.

The Competitive Challenge

The world's nations are moving from the traditional industrial economy towards a new economy based on technology and innovation. Science and technology already play a greater role in shaping the global economy than ever before. Extraordinary advances in areas like microelectronics, robotics, biotechnology and advanced industrial materials are transforming the way business operates, and the way nations compete in world markets.

These "strategic" technologies are closely linked, overlapping and building on each other at a constantly accelerating rate. And they have a dramatic influence on every business sector.

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With a broad range of applications, they cut capital costs, improve productivity, and give an industry a competitive edge in world markets. An authoritative study suggests that 44% of productivity gains in the U.S. can be attributed directly to such technological innovation.

The Race for Technological Survival

In the new economy, old ways of doing business no longer work. Many elements that used to give an industry a competitive advantage — such as access to natural resources, to nearby markets, and to large supplies of unskilled labour — are no longer decisive in themselves.

What counts now are knowledge and skills. Firms must be quick and efficient at assimilating new technologies. The same is true of nations.

What counts now are knowledge and skills. To remain competitive, a firm must be quick and efficient at assimilating new technologies and the managerial skills to bring them to market. And the same is true of nations.

Throughout the world, countries are in a race for technological survival. To stay competitive, they must develop their technological infrastructures, and intensify research and development in the critical strategic technologies. In fact, many countries are taking steps to secure an advantage over competitors through major technological initiatives — for example, EUREKA and ESPRIT in Europe, the Fifth Generation Computer program in Japan, and the Strategic Defense Initiative in the U.S.

Even the newly-industrializing nations, such as Brazil, Mexico, Hong Kong and Singapore, are joining the race and developing a sophisticated technological capacity. Their share of high technology products imported by the OECD countries has increased from less than 1% in 1964 to 12% in 1984.

The message is clear. Science and technology today must be at the top of the national agenda. And other countries are already making the investment required — tailoring major strategic programs in science and technology for economic and social development.

Canada's Performance in Science and Technology

Canada can take pride in its own achievements in science and technology.

Canada can take pride in its own achievements in science and technology. With some of the largest consulting engineering firms in the world we have developed a considerable expertise, particularly for mega-projects such as hydro-electric power and oil sands development. We are strong in telecommunications and energy technologies. Our aerospace industries have secured an important place in world markets for their high technology products.

Canadian universities, reflecting the best of English, French and American traditions, have world-class expertise in such emerging fields as lasers, synthetic fuels, remote sensing devices, computer software and hydrogen technologies. Our latest Nobel Prize winner, John Polanyi of the University of Toronto, is proof of this excellence.

Our government research facilities are well developed. Our climate and unique geography have given us special expertise in cold oceans technologies, agricultural research and the long-distance transmission of electricity. And provincial research organizations have helped to diversify and develop local industrial infrastructures.

Despite these strengths, our efforts in science and technology must be improved.

Despite these strengths, our efforts in science and technology must be improved to compare favourably with the performance of other industrial nations. According to a recent Statistics Canada report, our trade deficit for high technology goods and services is estimated at \$5.8 billion, and it is growing faster than our economy.

Efforts to improve Canada's science and technology performance must deal with a number of basic structural problems. Our science and technology infrastructure must be strengthened and developed in many areas.

Many Canadian industries rely on imported technologies to meet their needs, so that technological "spin-offs" to related industries do not occur. In 1986, a mere 25 firms were responsible for 54% of all industrial R&D expenditures in Canada. The private sector share of our total R&D effort, while

improving, is still low compared to other OECD countries. And corporate support for university research is especially low: only 3% of university research in Canada is funded by industry, compared to over 5% in the U.S.

Canadian industries are slow to adopt new technologies developed abroad. An Economic Council survey in 1980 found that the average lag for the adoption of new processes in Canada was nine years; for new products, the average lag was seven years. While more recent data suggests that the situation is improving, there is still a need to improve the diffusion of new technologies in Canada.

After a time of rapid expansion in the 1960's and 70's, our universities, colleges and technical institutes have found it difficult to finance their operations. This means they often cannot maintain state-of-the-art equipment and facilities and therefore attract world-class scientists or keep talented researchers. In 1983 Canada had only 2.7 research scientists and engineers per thousand workers, while the U.S. had 6.4.

A strong system is required to encourage the diffusion of technical information and technological ideas.

Government research facilities perform valuable work in many areas that could benefit private industry. But they need mechanisms to help transfer benefits to the private sector. Their efforts must be coordinated, and a strong system is required to encourage the diffusion of technical information or the commercialization of technological ideas.

The structural problems are reflected in our society. Canada needs to develop a better science "culture". We need a more coordinated effort to promote scientific and technological literacy in our society so that public and private sector measures can more easily take root.

The Need for Action

Today Canada enjoys one of the highest standards of living in the world. At 3.9%, the real growth of our gross domestic product exceeded all other major free-market economies in the past year.

Even the most advanced nations must make a constant effort to stay at the leading edge of scientific developments.

But as we enter the technological economy of the future, we can not take our good fortune for granted. Even the most advanced nations must make a constant effort to stay at the leading edge of new scientific developments. That effort is the only guarantee of staying on top in a rapidly changing economy.

For many years our economy has been based on raw materials and semi-finished goods made from these materials. In the economy of the future that foundation will be challenged. A more decisive action to renew our science and technology capabilities is now needed to prepare for that challenge.

The Canadian Strategy for Science and Technology

To date, the federal government has shown leadership through initiatives such as:

- strengthening university research through improved funding;
- launching a major Space Plan;
- streamlining the tax environment for R&D;
- developing science and technology partnerships with provincial governments; and
- funding the Canadian Institute for Advanced Research.

Isolated actions are not enough. We need a coherent strategy to coordinate efforts, clarify goals, and address basic structural problems.

After extensive consultations with Canada's scientific, entrepreneurial and engineering communities, there is widespread agreement that isolated actions, though valuable, are not enough. We need a coherent strategy to coordinate federal efforts, to clarify our goals, and to address basic structural problems.

InnovAction provides the strategy Canada needs. In developing this strategy, the federal government has been guided by four basic principles.

- (1) An increased commitment by industry to science and technology is essential to Canada's growth. The private sector must contribute significantly to efforts that will determine its own prosperity. The government's main role is to act as facilitator — providing an appropriate environment for innovation and entrepreneurship, and stimulating increased investment from the private sector.
- (2) Increased cooperation between industry, labour, universities, colleges and government is needed to ensure a maximum return on Canada's science and technology investment. In the past there has been too much fragmentation in our efforts; Canada can no longer afford the resulting waste.
- (3) The government must pursue research and development in the public interest. For example, the government has a clear role in the promotion of health, social, safety, and cultural goals. And government R&D activities are essential in the areas of national security and resource conservation. While individual projects may result in economic spin-offs, the primary responsibility is to the public interest.
- (4) Industry, universities and government must cooperate fully to acquire foreign technology. Canada can not remain competitive unless it acquires world-class technologies from whatever source. All sectors should be encouraged to undertake joint efforts with foreign governments, institutions and firms, taking part in leading-edge projects that would otherwise be beyond their resources.

These principles provide the essential background to InnovAction and determine the focus in five critical areas.

Industrial Innovation and Technology Transfer

InnovAction will help create a dynamic system for innovation and technology transfer.

InnovAction will help create a dynamic system for innovation and technology transfer. Technological innovation goes beyond basic research and development. It includes a series of linked stages — design, financing, production, marketing and management — leading up to the commercial introduction of a new product, process or service.

Countries that maintain strong links in this chain are best able to benefit from technological advances. And it is widely agreed that the innovation chain in Canada needs improvement. A prime candidate is the system which is supposed to support the transfer, diffusion and application of new technologies.

Canada's many technology diffusion centres need to be better linked together. Our corporate-university alliances should be more developed. Government research laboratories will be encouraged to assist the private sector. And government procurement procedures will be used more effectively to stimulate industrial innovation.

Both the federal and provincial governments have developed programs to address these and related difficulties. But more needs to be done.

Small Business and Technology

The interest of Canadian small businesses in technology exceeds that of small business in Britain, Japan, the U.S. and West Germany.

InnovAction will focus special attention on small businesses which lack the resources of large corporations. A recent survey shows that the interest of Canadian small businesses in technology transfer and innovation exceeds that of small businesses in Britain, Japan, the U.S. and West Germany.

The federal government has technological support programs and institutions that can respond to this growing interest. One of the most effective is the Industrial Research Assistance Program (IRAP) offered by the National Research Council. The program provides small businesses with practical assistance in all phases of the innovation cycle.

IRAP has been highly successful, and the demand for services currently exceeds the Council's resources. Given the central role small businesses play in our economy, strengthening the program must be considered.

Acquiring Technology from Abroad

Some 98% of all technology is developed outside this country. **InnovAction** will help Canadian firms acquire this technology.

Acquiring foreign technologies is also a key part of the technology transfer and innovation cycle. Some 98% of all technology is developed outside this country. **InnovAction** will help Canadian firms acquire this technology which is vital for international competitiveness.

A program in this area is the Technology Inflow Program (TIP) run by the Department of External Affairs. TIP uses government offices abroad to develop foreign contacts, and provides financial support to firms seeking access to foreign technologies.

The demand for assistance through TIP has already exceeded the present capacity of the program. With the vital importance of foreign technologies to domestic industrial innovation, ways to increase the capacity of TIP are being explored.

IRAP can also help small businesses bring in new technologies from abroad. The National Research Council has developed a strong partnership with External Affairs' Technology Inflow Program. Building on that partnership would help small firms acquire foreign technologies. Seed funding would be useful to help set up private sector technology brokerage houses which would eventually become self-financing.

The federal government will work to strengthen bilateral arrangements with other countries.

Our ability to acquire foreign technologies can also be improved by participating in bilateral and multilateral science and technology programs. Under **InnovAction** the federal government will work to strengthen bilateral arrangements with other countries, and seek new arrangements to enhance the work of our technology development officers and science counsellors abroad.

Improving Our Technology Centres

There are now many technology centres to provide general and specialized technical assistance to small business. The federal government provides financial support for many of these centres.

To improve their effectiveness, the government is implementing a new Technology Outreach Program which ties funding to performance. This will help give small businesses the supporting infrastructure they need to acquire critical skills and technologies.

Enhanced Procurement Policies

Procurement programs have a dramatic effect on industrial innovation, and they will be improved.

Government programs affecting technological goods and services can have a dramatic effect on industrial innovation. Both federal and provincial governments could make better use of such programs.

The government's Unsolicited Proposals Program (UPP), in place since 1974, has been very successful in encouraging industrial innovation. Through this program federal departments can respond to unsolicited proposals from the private sector. In 1985-86 the government awarded \$15 million through UPP.

According to a recent survey, UPP projects have an average rate of return in domestic and export sales of \$10 for each program dollar invested. This return, and the employment generated by the investment, are compelling reasons for strengthening UPP, especially for small companies and entrepreneurs.

Developing Strategic Technologies

InnovAction will increase efforts to develop strategic technologies — the major source of new employment and wealth in the future.

InnovAction will increase efforts to develop strategic technologies, such as microelectronics, biotechnology and advanced industrial materials. These technologies are inherently knowledge-based, spreading rapidly, and advancing at an incredible pace. They are expected to be the major source of new employment and wealth throughout the 21st Century.

Basic research, product development and production are all important parts of the innovation process. But generic applied research — research in areas that cut across industrial sectors — is critical to the development of the new strategic technologies. **InnovAction** will ensure increased support for this kind of research.

InnovAction will encourage new research and development partnerships across the country and internationally. It will encourage firms to form industrial research consortia for pre-competitive research, which few companies can afford to undertake single-handed. And it will encourage greater cooperation between universities and industry in the multi-disciplinary research needed for strategic technologies.

During the coming weeks special initiatives to stimulate the development of strategic technologies will be announced.

Effective Management of Federal Resources

In 1986-87 the government spent \$4.2 billion on science and technology activities. Of this, \$2.6 billion was spent on research and development, making the federal government the largest single investor in R&D in the country. Investments of this size must be managed wisely to get the most effective use of public resources, and to create a climate for greater investment by the private sector.

A Decision Framework for Science and Technology

The federal government has reviewed the entire range of its own science and technology activities in view of the InnovAction priorities.

Based on that review a new Decision Framework has been developed, providing a set of guidelines to coordinate and give direction to federal science and technology activities. It will also give Cabinet and the National Advisory Board on Science and Technology an overview of the objectives and performance of government programs.

The Decision Framework brings government decisions and policies in science and technology under one consistent set of principles. This will ensure that all federal science and technology programs are related to, and justified in terms of, three major goals: economic and regional development, support of government missions, and the advancement of knowledge and the supply of highly qualified people.

In addition, the Decision Framework recognizes that the private sector must be involved in setting priorities and sharing the costs of government research in support of industry. And whenever practical, federal science and technology activities will be performed in the private sector and universities.

The Decision Framework will ensure more informed government decisions, stronger activity in the private sector, a more cost-effective effort in science and technology.

The Decision Framework will ensure more informed government decisions and stronger activity in the private sector. The result will be a more coordinated and a more cost-effective federal effort in science and technology.

Encouraging Private Sector Investment

The government will encourage greater investment in science and technology by the private sector.

Over the past two years the federal government has introduced initiatives to encourage greater investment in science and technology by the private sector. Tax incentives have been strengthened, and special tax credits have been tailored to meet the special needs of small business. Guidelines for determining R&D tax incentives have been liberalized. Today Canada's tax incentive scheme is one of the most generous in the world.

Competition laws have been amended to reflect the trend towards research consortia among industrial firms. With these changes, firms can pool their resources through consortia more easily, and undertake generic research beyond the reach of an individual firm.

Efforts are underway to clarify intellectual property issues such as the protection of plant breeders' rights, software copyrights and industrial design. A key issue is the ownership of processes or products generated by publicly-funded research.

Finally, the trade environment for the export of Canadian technological products and services is changing. Negotiations are taking place on freer trade with the U.S. and more liberalized trade arrangements are being pursued with other nations in the context of GATT. Here the key issue is Canada's ability to have access to foreign technology and markets, and to compete on an equal footing with foreign based companies.

Science, Technology and Human Resources

Technological development and industrial innovation require highly qualified scientists, engineers, technologists and technicians, and a strong, flexible work force that can adapt quickly to technological change.

InnovAction will help our universities attract and keep world-class scientists. It recognizes the needs of specialized scientists and engineers to keep abreast of rapidly changing technologies through retraining and continuing education. It will help to encourage Canada's independent inventors and technological entrepreneurs.

These and related matters call for stable, long-term commitments on the part of governments and academic institutions. The National Forum on Post-Secondary Education announced in the Speech from the Throne will provide a valuable opportunity to discuss these commitments.

Providing Adequate Research Facilities

State-of-the-art facilities are essential if students and researchers are to keep up with technological developments.

Obsolete research equipment is a serious problem facing Canadian universities, undermining their ability to attract and develop first-rate scientists and researchers. State-of-the-art facilities are extremely costly, but they are essential if students and researchers are to keep up with technological developments.

Lack of funds for university research equipment has been identified as a major barrier to technological innovation. A Federal-Provincial-Territorial Working Group has now been established under the National Science and Technology Policy to examine this and other issues related to basic research in universities.

Adjustment to Technological Change

InnovAction will help Canada's work force adapt to technological change.

InnovAction will also help Canada's general work force adapt to technological change. As new technologies are introduced in the work place, some jobs become obsolete, new jobs are created, and new skills are required. Workers require a range of opportunities for retraining and skill development.

Working with business and labour groups, the federal government is conducting a number of initiatives to study the impact of technology in the work place. These initiatives give labour groups a chance to assess their needs in advance, and suggest new ways to respond to technological change.

The Canadian Jobs Strategy is already responding through programs such as Skill Investment and Skill Shortages. **InnovAction** will ensure that all federal apprenticeship, training and labour programs continue to support the needs of workers in a changing work place.

Promoting a Science-Oriented Culture

InnovAction will help to increase basic scientific and technological literacy in Canada. The degree to which we can achieve a national focus for Canada's efforts is largely dependent on the degree to which Canadians understand and appreciate the importance of technological innovation.

Education and Public Awareness

InnovAction will promote a more diverse approach to keep Canadians aware of, and participating in, science and technology.

InnovAction will promote a more diverse approach to keep Canadians aware of, and participating in, science and technology. It will encourage schools to play an active role teaching young people about the history, achievements and impacts of technology on society. It will support media efforts to communicate scientific and technological developments. The government will play a facilitating role, creating a positive social environment for science and technology.

There are a number of organizations and programs that already play an effective role in this process, such as the Youth Science Foundation, the Conseil de développement du loisir scientifique, and the Federal Public Awareness Program. InnovAction will bring added support for such organizations, along with support for science museums, new science magazines such as **Science and Technology Dimensions**, and public educational materials.

Science and Technology as National Priorities

Science and technology issues have been raised to the highest levels of decision making.

The image of science and technology will also be enhanced by consistently identifying key issues as national priorities. The federal government has created a National Advisory Board on Science and Technology, chaired by the Prime Minister. This is the first time in Canada that a board like this has been chaired by a Prime Minister and that science and technology issues have been raised to the highest levels of decision making.

The House of Commons Standing Committee on Research, Science and Technology also plays an important role. This Committee is a leading public forum for identifying and examining national priorities in science and technology, and has raised Parliament's interest in such issues as science education, advanced technologies and university research.

A Call to Action

Canada needs a coherent focus for a national effort in the international race for technological survival.

InnovAction provides the needed focus. It identifies the key areas where action is urgently required.

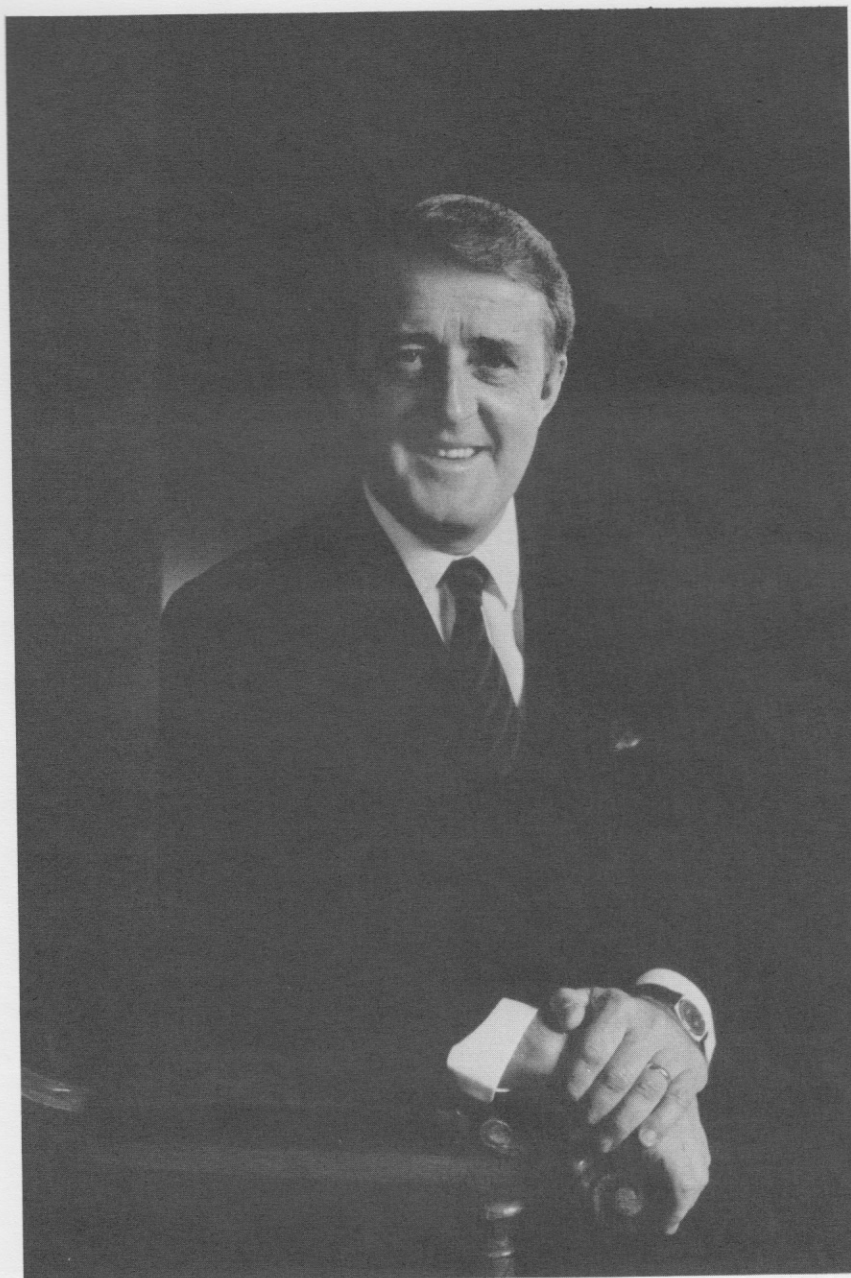
InnovAction provides the needed focus. It builds on those areas where Canada is strong. It strengthens those areas where we are weak. It identifies the key areas where action is urgently required.

The federal government has already taken several actions to implement the Strategy, where independent action is appropriate. Over the next several weeks additional actions will be announced, in consultation with the provinces and others who share an interest in science and technology.

On March 12, 1987, Canada's first National Science and Technology Policy was signed by the federal, provincial and territorial ministers responsible for science and technology. This historic agreement will ensure that science and technology are used to promote economic, social and regional development in Canada through ongoing cooperation among governments and between the public and private sectors. **InnovAction** will be implemented in full accord with the spirit and principles of the National Policy.

While these actions alone will not meet the international competitive challenge, they represent a step forward that will reap significant returns and lay the foundation for future initiatives. They embrace the future rather than hold on to the past.

The task now is to proceed with the further initiatives needed to address **InnovAction's** priorities. The federal government is determined to work together with all the key players to secure Canada's economic future.



"The Western World is moving toward knowledge-based economies and Canada must move with it. We want to be known not only as a resource-rich nation, not only as a trading nation, but as a nation known for our brain power, our ideas, and our intellectual and educational achievements. The issue is no less fundamental than how Canada will earn a living in the 1990's and beyond."

The Right Honourable Brian Mulroney

Address on Research and Development
University of Waterloo
March 4, 1987