Industry, Science and Technology Canada
Industrie, Sciences et Technologie Canada

CANADA'S SCIENCE & TECHNOLOGY RELATIONS WITH EUROPE

Canada

BACKGROUNDER

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A paper prepared to facilitate discussion at the March 1991 focus groups organized by the Association of Provincial Research Organizations (APRO) on behalf of Industry, Science & Technology Canada (ISTC) and External Affairs & International Trade Canada (EAITC)

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1.0 OBJECTIVES

This paper has been prepared as a backgrounder for use by focus groups organized by the Association of Provincial Research Organizations (APRO). The focus groups will discuss Canada's science and technology (S&T) relations with western Europe, defined as the European Communities (EC) and countries of the European Free Trade Association (EFTA).

The paper attempts to provide a starting point to facilitate these discussions. It does not attempt to be exhaustive; rather, it seeks to refresh the perspectives of the focus group participants, all of whom have considerable expertise on Canadian relations with Europe from their own vantage point. In short, the paper attempts to cover the most important facets of S&T linkages by asking questions and suggesting avenues for debate.

The primary question is:

Q1 - How can Canada promote and support its S&T relations with Europe in the context of strengthening Canada's economic, industrial, technological and scientific competitiveness?

2.0 THE GLOBAL CONTEXT

2.1 Introduction

The global competitive challenge concerns the ability of sub-national, national and supra-national entities to integrate the factors of investment, finance, trade, research and development (R&D), and the development and utilization of human resources.

Changes in the world economy in the last decade have increased the importance of technologically-based innovation as a source of competitive advantage whether for individual firms or for entire countries. Those countries with a solid infrastructure in terms of their educational institutions, the quality of their workforce, and the ability to acquire and adapt technology from elsewhere, have a competitive advantage.

2.2 Europe 1992: What's happening, and what does it mean for Canada?

The EC has initiated a legislative process encompassed in the expression "Europe 1992". By the end of 1992, this process will have removed the remaining barriers to the free movement of people, capital, services and goods in the 12 member states of the EC. The resulting market will have a combined population of 350 million people and over 25% of the world's gross domestic product (GDP).

This market will encourage trans-national synergies that were previously limited to a few specific sectors. One obvious example is the emergence of a single European capital market. Industry examples include electronics and aerospace.

The combined effort of the member states is seen as a European counterbalance to the USA and Japan. European national governments and the Commission of the European Communities (CEC), prompted by European industry, recognized that the small scale of individual national markets within the EC hindered competition with American and Japanese industry. In addition to the benefits from a unified market, the CEC has given special attention to areas central to economic competitiveness, such as information technology, in order to sustain a home-grown capability.

The ability to acquire and adapt technology from other countries is also key; for example, it has been the source of much of Japan's competitive advantage. To this end, among other reasons, many European firms are forming strategic alliances across boundaries, often involving firms from several countries. Similarly, the focus of CEC S&T program is to promote intra-EC cooperation. In the future, this may broaden to include other countries, particularly if the EC should sign many bilateral S&T agreements with non-EC governments.

While the EC's first external preoccupation is with the EFTA countries and with Eastern Europe (both are an important hinterland for the EC), Europeans have specific interests in other countries. Canada, for example, is seen by many Europeans as a convenient entry point to the Canada-USA free trade zone. Europeans also recognize the importance of the Asia-Pacific market, and are jostling with the USA and Japan for market share.

The enlarged Europe of 1992 offers a wide range of potential opportunities to Canadian researchers and business people. For example, if Canada succeeds in negotiating an umbrella S&T Framework Agreement with the EC (see section 3.3 below), we should then be able to negotiate financial and substantive participation in specific projects financed in part by the CEC's Third Framework Programme for Community Research and Technological Development.

Given the changes in Europe, we could say:

S1 - Two key issues for Canada will be:
a) the S&T "process" (using joint S&T projects to create and sustain scientific, technological and industrial competitiveness), and
b) working to match our S&T priorities and strengths to that of the Europeans.

2.3 Innovation clusters and strategic alliances: synergy of proximity, synergy of objectives - European and Canadian examples

The experience of the past several decades has shown that innovation is most likely to take place when a critical mass of scientists, engineers, technicians, inventors, entrepreneurs, venture capitalists (or other capital sources) is formed in one geographic region. Present activities suggest that innovation can also take place when a critical mass is formed through alliances and networks.

The first process has been taking place in the "Four Motors" of Europe (Lombardy, Italy; Rhône-Alpes, France; Baden-Wuerttemburg, Germany; and Catalonia, Spain), areas where the essential critical masses exist. The "Four Motors" are now moving to reinforce their collective positions in the EC through the second process.

In Canada, areas of critical mass are found in the innovation centres of Toronto and Montreal. Sector specific innovation clusters are also found in Canada, for example, the National Capital Region in electronics, and in Saskatoon in agriculture technology. Canada's "Centres of Excellence" policy, which promotes innovation through alliances and networks (the second innovation process), is also encouraging the linking of the diverse resources of academia, governments and industry, to profitable effect.

The relevance of innovation clusters to Canada-Europe linkages is primarily in the recognition that linkages can occur not only between countries, provinces, cities, companies, and institutions, but also among regions possessing coinciding objectives.

There is a comparable synergistic relationship between small- and medium-sized enterprises (SMEs) and multinational enterprises (MNEs). Many larger companies have recognized the innovative and technological capabilities of smaller firms as well as the smaller firms' inherent flexibility and adaptability. This has led to the establishment of alliances and other relationships with smaller firms.

An MNE, capable of harnessing and pulling together the full range of factors and actors, especially one closely associated with a particular geographic region, is in a good position to interact productively with its European counterparts. Similarly, a business association or a consortium of SMEs, acting with or without the participation of one or more large firms can also be effective. Most successful cooperative European S&T projects among small firms have at least one large corporate participant.

These observations suggest the following:

S2 - Canada must identify and/or create the instruments to reinforce Canada-Europe S&T relations so that Canadian innovation clusters, S&T networks and business associations are matched appropriately with those in Europe.

2.4 Summary of European Country Studies

R&D expenditure for the European members of the OECD[1] was approximately 1.6% of GDP in 1990 as compared to 2.8% each for the USA and Japan. However, three countries (Germany, the United Kingdom and France) together account for almost than three-quarters of total public and private expenditure on R&D in these countries.

Germany presents by far the greatest intensity of public and private research efforts, as well as the highest proportion of researchers in its active population. Within the EC, France is probably the most interventionist in the field of S&T. While the EC's research is non-military, spending for defence is particularly important in the UK (approximately 50% of total spending) and in France (34%).

As well as national differences in levels of spending on R&D, there are regional policy variations among these countries. Some countries emphasize public financing of fundamental research (Germany, France and the Netherlands in particular). Due to budgetary constraints, other countries (such as Norway), emphasize actions which are measurable in terms of cost/benefits.

The country studies in Annex A suggest:

S3 - An S&T strategy for Europe must be sensitive not only to the EC, but also to individual country S&T policies.

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[1]These 19 countries are: Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, United Kingdom, Austria, Finland, Iceland, Norway, Sweden, Switzerland, and Turkey. The first 12 comprise the EC. Yugoslavia, which has special country status in the OECD, has not been included in this calculation.

3.0 THE GOVERNMENTAL ROLE IN CANADA: FEDERAL AND NATIONAL INITIATIVES

3.1 Canadian technology strengths and government policy

Canadian federal government policies have been designed in order to match and nurture Canadian strengths, and to increase the value-added components of our traditional industries. Telecommunications equipment, computer, satellite and biotechnology industries have a vital S&T component. S&T is the base of trade and competition in resource-based industries like pulp and paper, steel, agriculture, and petrochemicals.

A cornerstone of these policies has been the role played by institutes such as the National Research Council (NRC) and other internationally prominent federal laboratories. Another cornerstone has been the funding of research through the granting councils; Natural Sciences and Engineering Research Council (NSERC), Medical Research Council (MRC), and the Social Sciences and Humanities Research Council (SSHRC).

To this solid foundation, new initiatives have been added:

- InnovAction, a Canadian strategy for S&T announced in 1989, encompasses: increasing industrial innovation and technology transfer (e.g. the Technology Outreach Program); developing strategic technologies; effectively managing federal resources; encouraging the development of science, technology and human resources; and promoting public awareness of S&T.

- The Networks of Excellence Program encourages the integration of research communities in industry, universities and government into interrelated grids stretching across the country. The 15 networks now established represent a cross-section of the natural and medical sciences and engineering; their industrial linkages will span manufacturing, resource and high technology sectors and businesses across Canada.

- Three primary contribution programs have had technology development as their overriding objectives. These are: the NRC's Industrial Research Assistance Program (IRAP), which supports Canadian companies in their efforts to expand through new product development by encouraging applied research in Canada; ISTC's Defence Industry Production Program (DIPP), which is aimed at developing and maintaining defence-related production capabilities; and the Industrial and Regional Development Program (IRDP), for projects which meet the dual objectives of support for innovation, and regional economic development and diversification.

- The federal government has supported the strategic alliance efforts of Canadian firms in the area of pre-competitive research in; artificial intelligence (AI), through organizations such as PRECARN Associates; and in information technology, advanced industrial materials, and biotechnology through both the Strategic Technologies Program; and through the National Biotechnology Advisory committee, and the National Advisory Panel of Advanced Industrial Materials.

- Perhaps the key indication of a pan-Canadian S&T consciousness is the National Science and Technology Policy, signed by thirteen ministers of federal, provincial and territorial governments in 1989, which brings S&T fully to bear on the economic, social, cultural and regional development of Canada by encouraging cooperation among governments, and between the public, quasi-public and private sectors.

- The Draft National Science and Technology Action Plan for Consultation is an initiative of the Council of Science and Technology Ministers (CSTM). This initiative is significant as it represents Canada's first attempt to plan a long term course of action on S&T. The elements of this draft action plan cover six specific issue areas: national commitment; R&D collaboration; innovation support; technology transfer/adoption/diffusion; human resources; and public awareness.

This brief review of government initiatives suggests that:

S4 - Canada's S&T strengths are the basis for broadening and deepening our S&T relations with Europe.

3.2 History of Canadian S&T Cooperation with Western Europe

Canadians have a multitude of links to Europe, through industry, research, institutes, and other organizations, most of which occurs without formal government involvement. This is all to the good. Government should encourage informal links. Where the situation warrants, the Canadian government (and many provinces) have worked out formal bilateral agreements or other instruments with European governments.

At the federal level in Canada, collaboration with Western Europe is taking place within general parameters established by the Canadian cabinet. These parameters specify that umbrella agreements and arrangements should follow and facilitate activities rather than leading them, and that extensive consultations with members of the Interdepartmental Committee on International Science and Technology Relations (ICISTR) are needed to ensure adequate support.

The process has led to formal umbrella agreements with Germany (the FRG), France and Belgium as well as a contractual link with the European Economic Community under the Framework Agreement for Economic and Commercial Cooperation. Less formally, after 1982, Canada has exchanged letters with Norway, Finland and the UK. A request for negotiating a formal S&T Agreement with the EC was made by Canada in 1989.

For the most part, the agreements and arrangements are serving their purpose. The German agreement is the most active with 108 projects while France encompasses 98. The two agreements use the consultation process to maintain a positive climate, reconcile priorities and deal with trouble spots. The exchanged letters are not fully proven but focus on sectors identified as being complementary. They take advantage of Norway's and Finland's obvious interest in collaboration.

The contractual link with the EC has permitted some cooperation, for instance, in energy research, but proved inadequate for tapping the Community's full potential for industrial research. Discussions related to the negotiation of a broader S&T agreement have started, primarily to provide access to the CEC's Third Framework Program for Community Research and Technological Development.

On a multilateral basis, Canada has participated in the European EUREKA program and is a member of the European Space Agency (ESA). Canadian participation in the EUREKA experience was supported by the Technology Opportunities in Europe Program (TOEP), which had limited success. The Canadian Space Agency has concluded that our investment in ESA has been multiplied many times by the return. However, Canada has had only limited funding to place in ESA.

Traditionally, financial support for S&T activities has come from participating departments or agencies and the Provinces. Consistent with the principle underlying our agreements, the need to fund one's own participation has acted as a screen to ensure activities fit within the participant's priorities. In 1987, in order to encourage Canadian companies to participate in EUREKA, Industry, Science and Technology Canada (ISTC) initiated TOEP, a two year program. More recently, a modest fund was established by External Affairs & International Trade Canada (EAITC) for S&T cooperation in Western Europe ($0.5 million per year for five years), under the Going Global trade strategy. One of the uses of the latter is to finance a review which evaluates the Canadian approach to Europe including the need for supplemental funding. Most of this fund, however, is used as seed money to stimulate new collaborative R&D projects involving university researchers and the private sector.

The amount of funding has caused difficulties in managing S&T agreements. The overdependence on government sources has also been problematic. This has made it difficult to support some potentially beneficial activities and to coordinate participation by Canadians in S&T agreements. For instance, the Canadian government has been criticized by Germany for not matching their support for S&T collaboration.

This section of the backgrounder suggests that:

S5 - We need to consider closely how to sharpen and focus our S&T agreements and arrangements to better reflect Canadian S&T goals.

3.3 Framework Agreement for S&T Cooperation Between Canada and the CEC

Canada and the CEC have been discussing a Framework Agreement for Science and Technology Cooperation. Such an instrument is a legal necessity if Canada wishes to gain access to the CEC's Framework Programmes.

Canada has begun to identify the kinds of projects where it would be able to contribute substantially to European S&T priorities. The CEC's Third Framework Programme, together with the overlapping work emerging from the Second Programme, will release funding of ECU 8.8 billion over the next five years (1 ECU equals approximately C$ 1.60). Given the European interest in project collaboration, involving industry, institutes, and universities drawn from across Europe, Canadian partners may have interesting opportunities to participate in R&D projects.

Conditions Canada might seek in new S&T agreements with Europeans, whether multilateral or bilateral, are:

- meaningful participation by SMEs, not just by government or university laboratories and institutes;
- that Canadian industry become involved in joint venture technology development projects;
- that Canadian participants enjoy access to the decision making and the results of cooperation;
- that projects and activities may be located in Canada, featuring the participation of European companies and institutes;
- that Canadian companies not be required to have a presence in the other country/countries to be able to participate; and
- that there be recognition of Canada's own sectoral priorities and centres of excellence.

These points suggest that:

S6 - Canada needs to have specific S&T objectives in mind and strategic projects "in-the-making" before we negotiate an S&T agreement with the CEC.

4.0 TECHNOLOGY & COMPETITIVENESS: A CHANCE FOR A CREATED ADVANTAGE

4.1 Porter and OECD perspectives

As section 2.0 on the global context suggested, one of the key factors for success in the evolving international competitive environment is the ability to focus and to integrate a range of policies, programs and activities. This range encompasses investment, finance, trade, R&D (including technological innovation) and the development and harnessing of managerial and human resources.

According to Michael Porter of the Harvard Business School, national prosperity is created, not inherited. It does not grow out of a country's natural endowments, its labour pool, its interest rates, or its currency's value, as classical economics insists.

A nation's competitiveness depends on the capacity of its industry to innovate and upgrade. Companies gain advantage against the world's best competitors because of pressure and challenge. They benefit from having strong domestic rivals, aggressive home-based suppliers, and demanding local customers.

There are striking differences in the patterns of competitiveness in every country; no nation can or will be competitive in every or even most industries. Nations succeed in particular industries because their home environment is the most forward-looking, dynamic and challenging.[2]

Similar refrains were voiced from a different perspective at the OECD International Conference on Technology and Competitiveness held in Paris, June 1990[3]. This conference focused on the dynamics of created advantages. Participants noted that the most efficient enterprises based their competitive strategies on four elements: the intensive use of information technology; in-house R&D; control over organizational factors; and sophisticated skill management. The result of the conference was a set of proposals for enhancing national competitiveness in a context of internationalization.

These are:

- developing long-term research, by continuing to share the burden with industry of the associated high costs and financial risks ;
- developing intangible infrastructure, such as networks and standards;
- developing physical infrastructure, such as communication and telecommunication networks;

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[2]Michael Porter, "The Competitive Advantage of Nations", Harvard Business Review (March-April 1990) pp. 73-74.

[3]Technology and Competitiveness - The dynamics of created advantages Paris, 25-27 June 1990, OECD Conference.

- developing human resources through training; and

- protecting the competitive environment, by not allowing cartelization to undermine it.

4.2 Potential avenues for action

Given:

- the opportunities of Europe 1992 (and indeed the resultant advantages from being successful in this market which would be used by Canadian companies in other world regions),

- the existing and proposed Canadian government activities in S&T both in Canada and vis-a-vis Europe, and

- the insights of Porter and of the OECD,

we reiterate the initial question and the suggestions made in this paper.

Q1 - How can Canada promote and support its S&T relations with Europe in the context of strengthening Canada's economic, industrial, technological and scientific competitiveness?

S1 - Two key issues for Canada will be:
a) the S&T "process" (using joint S&T projects to create and sustain scientific, technological and industrial competitiveness), and
b) working to match our S&T priorities and strengths to that of the Europeans.

S2 - Canada must identify and/or create the instruments to reinforce Canada-Europe S&T relations so that Canadian innovation clusters, S&T networks and business associations are matched appropriately with those in Europe.

S3 - An S&T strategy for Europe must be sensitive not only to the EC, but also to individual country S&T policies.

S4 - Canada's S&T strengths are the basis for broadening and deepening our S&T relations with Europe.

S5 - We need to consider closely how to sharpen and focus our S&T agreements and arrangements to better reflect Canadian S&T goals.

S6 - Canada needs to have specific S&T objectives in mind and strategic projects "in-the-making" before we negotiate an S&T agreement with the CEC.

APPENDIX A - SUMMARY OF INDIVIDUAL COUNTRY STUDIES[4]

Belgium

Belgium's R&D expenditures were 1.5% of its Gross Domestic Product (GDP) in 1989. The portion of R&D financed by the private sector was 1.2% of GDP. In Belgium, the major universities have a strong reputation and a long-standing tradition of cooperation with the industrial community. The Union des Centres de Recherche Collective (union of collective research centres) comprises thirteen centres of expertise established by the industrial sectors.

The principal national research programs are: activities in the space sector; aeronautics programs; a national incentive program for basic research in the life sciences; a scientific research program in the field of spaceborne remote sensing; an incentive program for fundamental research on artificial intelligence; inter-university centres of attraction; and the European Community Framework Program for Community Research and Technological Development.

Both the Walloon and Flemish regions of Belgium also have policies on research, development and technologies.

Denmark

R&D expenditures in 1989 were 1.5% of GDP. It is the goal of the Danish government that this be increased to 2.0% during the 1990s, with the main increase from the private business sector. Government support to industrial R&D consists of two main elements: support for the technological infrastructure in order to assist SMEs; and co-financing schemes and programs aimed at high technology promotion, collaboration among firms and selected industrial sectors.

Smallness is a characteristic feature of Danish enterprises in both manufacturing and other sectors. A result has been the development of niche production to overcome competition from major industrial neighbours. Areas of S&T strengths include: pharmaceutical, electronics and instrumentation, biotechnology (particularly within the agri-food sector), environmental technology, and wind energy technology. A particular feature of the Danish niche-oriented industry is its ability to develop industrial applications from basic S&T.

European Communities (EC)

In the EC, R&D is implemented within overlapping five-year "Framework Programmes for Community Research and Technological Development". The Third Framework Programme (1991- 1994) has a budget of ECU 5.7 billion (approximately C$ 8.1 billion), with 15 specific programs grouped under three main headings; enabling technologies, management of natural resources, and management of intellectual resources.

Full participation of third countries (which includes Canada) in the CEC's Framework Programmes must be within the framework of a formal agreement. However, as Canada does not have a formal S&T agreement with the EC, full participation is not possible. Limited participation is possible in certain categories, but for these categories, the Canadians are not eligible to have access to the proprietary information and intellectual property developed in the project and specific program.

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[4]Canadian missions in Europe provided full reports for this paper, from which these summaries are derived.

Finland

Particular features of R&D in Finland include the relative importance of the public sector, the sharp upsurge of interest in industrial research in the 1980s the increasing diversity of university research and the broad interest in international co-operation. R&D expenditures in 1989 were 1.8% of GDP. The real growth in the R&D expenditure since 1987 has been approximately 10% a year, the fastest growth rate of the OECD countries.

In letters of Intent on Cooperation in Science and Technology, exchanged between Canada and Finland, the fields of forest products, cold region building construction, roads and marine transportation, fisheries and leisure were named as specific areas of interest.

France

Within the EC, France is probably the most interventionist in the field of S&T. France dedicates about 2.4% of its gross national product (GNP) to R&D. The government has established a progressive target of 3.0% of GNP to be dedicated to R&D, and has also set objectives to increase the share of the national R&D effort from industry. France takes a lead role in S&T through the very large national R&D organizations, and through control and ownership of many of the largest companies in France.

In industrial research, main policy thrusts are aimed at: new initiatives to stimulate innovation in firms; fostering technology development in SMEs; and supporting French participation in large international S&T projects. Areas of S&T strengths are: the nuclear sector, the space sector, aeronautics, rail transport, oceanology, polar research, advanced materials, medical research, water treatment, artificial intelligence and software engineering.

Some Canadian provinces, Quebec in particular, have already established extensive S&T cooperation programs with France. Some 50% of the cooperation program between France and Quebec is now dedicated to S&T.

Germany

In the EC, Germany represents by far the greatest intensity of public and private research efforts, as well as the highest proportion of researchers in its active population. In 1989, 2.9% of GNP was spent on R&D by the government and the private sector, a real growth of 35% over the last decade. This places Germany together with the USA and Japan as the top three S&T nations. Three major new factors which will have an effect on Germany's R&D spending in the next few years are: the costs and problems of unification, the downturn in the global economic climate, and potential competition for available capital with the USA.

Recent government policies include: the announcement of new guidelines and orientation for the 13 National Research Centres; and the "8-point" program on perspectives for R&D in the united Germany. Although support for industry has decreased in general during the past decade, SMEs were marked for special attention in a variety of new programs.

More emphasis is to be placed on market-oriented technologies, such as information technologies, biotechnology, material sciences, and physical sciences, as well as on energy efficiency and renewable energies, marine sciences, and health related disciplines. S&T opportunities for Canada exist predominantly in the fields of information technologies, telecommunications, and environmental technologies.

Italy

The total R&D expenditure for 1998/89 in Italy is estimated at 1.3% of GDP, of which 66% goes to the public sector. This proportion can be misleading, since the Italian public sector includes not only actual government agencies, but the state holding companies and their subsidiaries, many of which engage in direct industrial production.

It is difficult to quantify R&D expenditures and efforts of the private sector, since an estimated 30% of all research carried out in Italy is in the hands of major industrial conglomerates. These groups have participated in research in the fields of: industrial robotics and factory automation; aeronautics; public transport; electronics; defense products; agro-industry and biotechnology; petrochemicals; electronics; parallel computing; and production systems.

Collaboration projects between Canadian agencies and private companies, and Italian government agencies and state sector companies are hampered by the lack of a bilateral S&T agreement, as nearly all projects depend on government funding, for which cooperation projects with Canada are not eligible at present.

Netherlands

R&D expenditures as a percentage of GNP in 1987 was 2.3%. About 44% of R&D is financed by the government, 52% by private companies, and the remainder by private, non-profit and foreign sources. Almost 87% of R&D is performed by the private sector, dominated by the metal and chemical industries.

The government runs technology programs in the fields of materials technology, information technology, biotechnology, environmental technology, and energy technology.

Norway

Norway's R&D structure is small and its funding level is lower than most OECD countries. There are a limited number of industrial firms capable of making R&D expenditures. At present, the ratio of private to public funding is such that more private funds are spent on R&D. The current government stresses equal funding between industry and government research institutions, especially in the commercialization of technology. The result has been a market oriented approach to research. The bulk of R&D funding is used to finance industrial R&D activity.

The eight priority ares of research for Norway are: information technology; biotechnology; aquaculture; material technology; oil and gas; organization management and administration; traditional and cultural dissemination; and health environment and living conditions. In particular, Norway has had success in R&D in salmon aquaculture, in the use of light metal technology (magnesia) and in offshore oil production structures.

Spain

R&D expenditures in 1990 were about 0.5% of GNP. Spain's goal is to reach a total expenditure of 1.1% of GNP in 1991. The National Plan for Scientific Research and Technological Development is the basic instrument for the planning, development and coordination of the Spanish system of S&T.

The distribution of expenditure by type of research is approximately 20% on basic research, 35% on applied research, and 45% on technological development. The universities constitute the most important potential source of research in Spain since they account for 60% of all scientists. However, at present, the private sector is responsible for just over half of the R&D carried out in Spain. Companies generally finance for 50% of their total R&D expenditures themselves, while the public sector provides the rest. Various ministries also operate their own public research institutions.

Significant opportunities for Canada lies in cooperation in the areas of: advanced technologies; defense; transport; environment; and education, medical and health sciences.

Sweden

Sweden spends approximately 3% of GDP on R&D, one of the highest percentages in the world. Almost 30% of R&D expenditures are made by universities. The purpose of R&D activities in the business sector is largely to promote companies' industrial operations, with just over 80% of R&D expenditure for product development.

Sweden's great S&T strengths are its abilities to; encourage private sector research; transfer public sector research results to the private sector; integrate public and private sector research programs; and react quickly to new priorities and opportunities.

While ample opportunities exist for cooperation and exchange between Canada and Sweden, differences in organization and approach must be taken into consideration. Sweden has a decentralized and very flexible system where significant decisions are made at the university department level.

Switzerland

Switzerland has a ratio of 3% of domestic gross expenditure on R&D (GERD) to GDP. The Swiss government accounts for only 20% of GERD. While the Swiss government has not traditionally played a large role in applied R&D, support is now slowly increasing.

The Swiss industry R&D can be described as dependent on a small number of large firms operating in a few sub-sectors. Four MNEs account for more than 60% of expenditures, and almost all private R&D can be accounted for by chemical (mainly pharmaceutical) firms, electrical engineering; and machinery and metallurgy.

The Swiss government has targeted information technologies, environmental science and biotechnology in its recent policy statement. The former represents an area of opportunity for Canadian firms.

United Kingdom (UK)

The UK has the fifth highest expenditure in S&T in the OECD, with expenditures on R&D of 2.3% of GDP. About 45% of this is funded by industry, and 55% by industry. R&D in the UK is performed predominantly by industry (69%) with universities and government laboratories sharing the remainder equally.

Among all the OECD countries, the S&T situation in the UK is closest to that of the USA with: large military R&D spending; strong industrial funding of R&D; a large proportion of government laboratories partially privatized; a small government-controlled business sector; and no S&T policy as such.

The areas where the UK is strongest include: marine S&T (offshore oil and gas, aquaculture, and basic ocean research); chemicals; pharmaceuticals; advanced materials; computer software (including Artificial Intelligence); biotechnology; automotive; aerospace; and environmental industries.