Canadian Government Participation in International Science and Technology

by Jocelyn Maynard Ghent

The Norman Paterson School
of International Affairs

Background Study 44
Science Council of Canada

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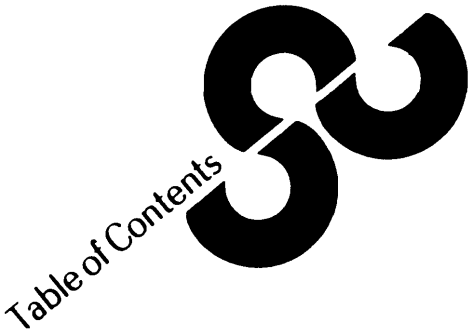
Jocelyn Maynard Ghent

Jocelyn Maynard Ghent completed this study when a post-doctoral research fellow at the Norman Paterson School of International Affairs, Carleton University. An Ottawa native, she received her PhD from the University of Illinois, Urbana-Champaign, in 1976. Her dissertation, "Canadian-American Relations and the Nuclear Weapons Controversy, 1958-1963," was supported by a Canada Council Doctoral Fellowship. Elected to both Phi Beta Kappa and Phi Kappa Phi, she has also been the recipient of a Canada Council Research Grant, University of Illinois Fellowship, and Woodrow Wilson Fellowship. Within the last year, Ms. Ghent has delivered papers and participated in panel discussions at meetings of the American Historical Association, Canadian Association of Slavists, Social Science History Association, and Association for Canadian Studies in the United States. A co-authored article, appearing in the Autumn 1976 issue of *Business History Review*, recently won the Newcomen Society in North America Award in Business History.



Foreword

Most industrialized nations and many of the emerging Third World countries, now recognize the crucial importance of scientific and technological activities to their continued prosperity. The transfer of technology from country to country, and the conditions under which it is exported, are policy issues of significant concern. Canada, itself has become increasingly involved in bilateral and multilateral science and technology relationships. In fact during the past decade Canada has more than doubled the number of its international science and technology agreements.

The Science Council has long been concerned about the "true" value to Canada of these agreements and has commissioned this study to look at their ramifications. *Canadian Government Participation in International Science and Technology* has been researched and written by Dr. Jocelyn M. Ghent as a contribution to Council's review of Canadian industrial and technology policy. The study focusses on the bilateral activities of the federal government with the developed world, and the more advanced countries in the developing world.

When signing science and technology agreements Canada like most other countries anticipated more than scientific and technological benefit. Economic and political objectives were a prime consideration. The study shows that significant political benefits have accrued, however, anticipated economic gains have been slow to materialize. Decisions were not anchored to substantive economic policy.

One might hope that recent emphasis on redressing the imbalance will result in an integrated Canadian approach for continuing access to global science and technology.

As with all background studies published by the Science Council, this study represents the views of the author and not necessarily those of Council.

J. J. Shepherd
Vice-Chairman
Science Council of Canada

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J.M.G.

I. Introduction

Over the last few years, science policy studies have focussed increasingly on the relationship between post-World War II developments in science and technology and changes in the international system. In discussing the significance of the link, analysts have pointed to a number of striking examples: the emergence of global technologies, the destructive power of nuclear weaponry, the impact of health advances on population density, the threat of environmental deterioration, and shifting patterns of resource dependency. Analysts have also drawn attention to the consequent growth of interdependence among nations, and to the accompanying impact on modes of interaction. As one observer stated, transnational relationships "have flourished," formal intergovernmental relationships "have grown at an explosive rate," and today "no international organization is without a substantial role in science and technology." Resultant alterations in the domestic policy process have also been noted. Science and technology have contributed "directly and massively" to changes in the foreign policy-making structures of all governments, particularly in the more industrialized countries, and "international developments have in turn been important factors in national science policies."[1] According to a recent US Congressional report, scientific and technical achievements since 1945 have also led the nations of the world "to recognize technology itself as a principal foundation" of national power and international influence. "Technology has moved to center stage in the world diplomatic scene."[2]

As one of the most advanced countries of the world, Canada has been subject to all the changes brought about by new interconnections between science, technology, and international affairs. The growth of interdependence, and its acceleration since the mid-1960s, has been reflected in Canada by progressively greater involvement in myriad bilateral and multilateral science and technology relationships. Within the last decade, Canada has doubled the number of scientific attachés at its embassies abroad, and more than doubled the number of its international science and technology agreements. New relationships have been developed as a response to the emergence of globally significant scientific and technological issues. The problems created by just one issue – pollution of the international environment – have led to new forms of bilateral cooperation between Canada and the United States, and to participation in a host of multilateral activities conducted under the auspices of such organizations as the United Nations Environment Program and the Economic Commission for Europe, the United Nations Specialized Agencies, the Organization for Economic Cooperation and Development, (OECD) and even NATO (through the civilian Science Committee and the Committee on the Challenges of Modern Society). Similarly, the opportunities presented by the development of one global technology – the exploitation of outer space – have led to a substantial expansion of both bilateral and multilateral relationships, with decisive effects on the formation of a national science and industrial policy.

Canada's deepening involvement in international science and technology represents more than a response to the demands of interdependence. The accelerated growth of the latter phenomenon coincided with the government's recognition of domestic science and technology as an increasingly important element of the foreign policy process. Canadian knowledge and expertise were commodities that could be traded for continued access to global scientific and technological advance. They could also be exploited internationally for various economic and political objectives. This perception, which evolved

slowly through the 1950s and early 1960s, found its initial expression in technical assistance arrangements with underdeveloped countries, and in technical-industrial exchange programs carried out in pursuit of commercial benefits. Under the Pearson government, the idea was further developed and formalized. Canada's scientific and technological excellence would be used to improve the overall course of relations with a particular country. As the Science Council has observed, the development of scientific relations is one of the "most unobtrusive ways of 'opening doors' . . . . Friendly relations and partnerships are encouraged by more intensive communication between scientific élites . . . ."[3] Hence, in 1965, Canada signed an intergovernmental agreement with France to promote scientific, technological, and cultural exchanges, and began planning the negotiation of a similar agreement with the Soviet Union.

The advent of the Trudeau government in 1968 brought a heightened awareness of the relationship between domestic capabilities in science and technology and Canada's role in world affairs. In its White Paper on foreign policy, the government stated its firm conviction that:

> "Canada's most effective contribution to international affairs in future will derive from the judicious application abroad of talents and skills, knowledge and experience, in fields where Canadians excel or wish to excel (agriculture, atomic energy, commerce, communications, development assistance, geological survey, hydro-electricity, light-aircraft manufacture, peacekeeping, pollution control, for example). This reflects the Government's determination that Canada's available resources . . . will be deployed and used to the best advantage, so that Canada's impact on international relations and on world affairs generally will be commensurate with the distinctive contributions Canadians wish to make in the world."[4]

The Trudeau government regarded the foreign deployment of Canadian expertise in agriculture, atomic energy, communications, pollution control, and numerous other scientific or technological fields not only in terms of world impact and potential contribution, but also in terms of a closer tie between domestic and foreign elements of policy. Both elements would be designed to serve the same national purpose. The government viewed foreign policy as "the extension abroad of national policy," and structured the broad framework of its external relations within six main themes or principal goals that were identified as the "totality of Canada's national policy." Each of these stated objectives – the fostering of economic growth, the assurance of a harmonious natural environment, the enhancement of the quality of life, the promotion of social justice, the furthering of peace and security, and the safeguarding of sovereignty and independence – encompassed, to a greater or lesser degree, a rationale for vastly expanded government involvement in international science and technology.

A foreign policy for economic growth would include keeping up to date with, and maintaining access to, the rapid scientific and technological advances of other nations. It would also include innovative efforts to promote trade and enlarge markets, at least partly through the mechanism of cooperative scientific and industrial exchange agreements. A wide range of new technological problems that "lie squarely within the closely related policy themes Quality of Life and Harmonious Natural Environment" would require "solid international cooperation." The extension of "Social Justice" to the inter-

national sphere would mean an expansion of the Canadian commitment to technical assistance programs for the developing countries. A contribution to "Peace and Security" would be achieved by promoting detente through intergovernmental science and technology agreements with the Soviet Union, and by inaugurating scientific and technical exchange programs with China. The sixth policy theme, "Sovereignty and Independence", would be implemented in part by the development of new science and technology relationships with Europe and Japan. Although "most scientific and technological activities in Canada will remain largely oriented toward the United States . . . there would be much merit in seeking to develop at least some measure of countervailing influence."[5] A rationale for increased participation in international science and technology might also evolve, of course, from any mix of policy themes. The establishment of scientific relations with countries in the francophone world, for instance, would relate both to sovereignty and independence (protection of Canada's constitutional authority and national identity), and quality of life (enrichment of Canada's bilingual nature).

Since a decade of Trudeau government has coincided with the period of most rapid expansion of federal participation in international science and technology, the increasing involvement will be viewed within the context of the Trudeau administration's conception of the foreign policy process. In particular, the expansion will be understood within the framework of the government's heavy emphasis on carefully defined "national interests" as the paramount criteria in foreign policy decision making. Such an approach should help to explain the largely political character of many of Canada's bilateral science and technology agreements, and the significant increase in their number. Other countries went through a similar period of expansion and negotiated numerous science and technology agreements for primarily political reasons. But the Trudeau government's attempt to integrate, more closely, domestic priorities with international objectives frequently determined a rationale that was peculiarly Canadian.

This study is an attempt to detail the Canadian experience, to go beyond the first "broad-brush" effort undertaken by the Science Council in 1973. The focus is on the bilateral activities of the federal government with the developed countries, and the more advanced nations of the developing world, in the various non-military sectors of international science and technology. Multilateral activities are briefly touched upon, but a substantive analysis would require separate study. Canadian involvement in UN agencies and on UN committees, within the OECD, NATO, Commonwealth organizations, and other international forums is too diffuse and varied, and cannot adequately be inventoried here. For similar reasons, technical assistance agreements are excluded. The science and technology component of Canada's foreign aid program over the last 30 years is a complex topic that deserves separate examination. Defence science agreements also form a special category. The technological and industrial benefits to Canada of cooperation in defence research and development, especially with the United States, is a very broad subject requiring a somewhat different perspective. Canada's six defence science agreements with European allies are listed in Appendix A, but are discussed in the text of this study only as illustrations of a particular type of agreement. Finally, the participation of provincial governments in international science and technology is mentioned wherever provincial involvement is relevant to discussion of a federal agreement. Over the last decade, however, the

provinces have emerged as important international actors, with a wide range of international scientific and technological concerns. Provincial activity in this key policy area, both in liaison with the federal government and in pursuit of autonomous interests, is a topic of far-reaching significance that also merits separate review.

II. The Policy-Making Structure of the Federal Government

Organization: 1945–1970

Prior to 1945, the National Research Council (NRC) was the body chiefly responsible for the conduct of Canada's international scientific relations. In the two decades following the war, the creation of new science-based agencies in fields like atomic energy, defence science, and medical research, and the expansion of foreign programs and contacts in other sectors such as agriculture, fisheries, and resources brought a very substantial proportion of federal international scientific activity outside the jurisdiction of the NRC. The Council retained a leading role, and chaired such interdepartmental committees as the Advisory Panel on Scientific Policy, but the agencies involved considered that mission-oriented science was their own responsibility, along with the foreign interactions that accompanied it. External Affairs, like its counterpart ministries in virtually every other nation, was slow to recognize the way in which science and technology had come to pervade international politics.[1] Specialized administrative units geared to handle the phenomenon were not created in most countries until the 1960s; up to that time the responsibility had remained diffused among science-based departments.

Cabinet, which holds the final responsibility for policy making, is dependent on the expert advice of the bureaucracy. The creation of the Science Secretariat within the Privy Council Office in 1964, and the establishment of the Science Council in 1966, reflected the government's concern with the development of a national science and industrial policy, but the organizational structure still neglected the international dimension. NRC's International Relations Office had an informal monitoring function, and chaired a Standing Committee on External Relations (with External Affairs as an observer beginning in 1969), but as international science and technology activities expanded, administration and control grew increasingly fragmented. Different government departments were now engaging in international science and technology relations on a growing number of bilateral fronts. For example, AECL (Atomic Energy of Canada Limited) concluded an agreement with the USSR State Committee for Science and Technology in 1964, with the Mines Division of Energy, Mines and Resources (EMR) following suit in 1965. NRC signed exchange agreements with Brazil in 1968 and Czechoslovakia in 1969. A 1965 General Agreement with France produced provisions for scientific and technical cooperation, which were then administered by External Affairs' Cultural Affairs Division. Interdepartmental consultation proceeded on a primarily *ad hoc,* and frequently unsatisfactory, basis. Even the procedures used for selecting Canada's representatives to the meetings of an increasing number of multilateral scientific organizations were not uniform. The Science Secretariat picked the delegates to the OECD group, for instance, and NRC, with External Affairs' assistance, chose the delegates to the NATO Science Committee. The acceleration of activity in the latter half of the 1960s and the clear absence of a central focus within government for control and coordination pointed to the need for organizational change.

The government's developing perception of science and technology as a valuable tool of international political and economic relations also suggested the need for change in both inter- and intradepartmental structures. Until the mid-1960s, the initiative for science and technology agreements had come from the science-based agencies, which undertook international cooperation as a means of accomplishing their departmental missions. Except for the 1965 General Agreement with France, Canada's international science and technol-

ogy relationships had always assumed the form of area- or project-specific arrangements, or of interagency understandings covering the exchanges of personnel and information. But the French agreement, and a 1966 Cabinet decision to proceed with the negotiation of a similar cultural, educational, scientific, and technical agreement with the Soviet Union, reflected a new awareness of international science and technology as an aid in the promotion of non-scientific national goals. The idea had begun to emerge that Canada's scientific and technological excellence could be used abroad, by means of general agreements, to further certain foreign policy and commercial objectives.

Since the 1950s, the Department of Trade and Commerce had sponsored informal technical exchange programs to promote Canada's export goals. Such programs were viewed as one way of demonstrating Canadian capabilities in high-technology fields and thus opening up new markets for Canadian manufacturers. The reorganization of Trade and Commerce in the late 1960s, and its amalgamation with the Department of Industry resulted, as well, in the creation of new machinery designed to cope with the projected formalization and expansion of industrial exchanges with the Soviet Union. This division of IT&C, the Office of Science and Technology,[2] eventually assumed not only the planning and administrative responsibilities for a Soviet agreement, but also carried out the industrial cooperation provisions of subsequent science and technology agreements with other countries.

External Affairs was not engaged in a similar bureaucratic overhaul, and internal change geared toward the new emphasis on science as an instrument of diplomacy was achieved with a little more difficulty. Some members of the department had begun to argue in the mid-1960s that the overseas operations of the science-based departments should be more in harmony with Canada's foreign policy objectives. After the "quiet revolution" for example, the NRC Fellowship Program was criticized for providing only 11 grants (out of 1000 distributed between 1961 and 1966) to French scientists, while 183 had been given to Japan and 150 to India. A new departmental mechanism, some felt, would be needed to promote scientific liaison in accordance with the pattern of Canada's external policies. As might be anticipated, however, the Cultural Affairs desk and a few of the geographical divisions resisted the establishment of a separate scientific relations bureau as a potential infringement of area perogatives. Cultural Affairs had been overseeing the science and technology provisions of the French accord, and the division naturally expected to retain that responsibility for similar agreements that were now being planned. Nevertheless, the views of those who sought to distinguish scientific exchange from cultural relations held sway, permitting the then External Affairs Minister Mitchell Sharp to tell a Commons committee in 1971 that "the sudden multiplication of activities related to the quality of life has not caught the Department unprepared. The Scientific Relations and Environmental Problems Division was established in 1970 and reorganized this year as the Bureau of Economic and Scientific Affairs."[3]

The restructuring of IT&C and the resolution of jurisdictional difficulties within External Affairs had settled part of the organizational problem, but the relative roles of NRC and the Science Secretariat remained in question. In the development of Canada's international science and technology relationships, IT&C and External Affairs were responsible for providing the economic and political perspectives, but the question remained of which agency should assume the primary responsibility for coordinating the scientif-

ic viewpoint. NRC, in view of its experience, contacts, and traditional involvement in global science, appeared to have the strongest claim. On the other hand, the Science Secretariat had been working with External Affairs on such tasks as the planning for umbrella agreements, and the setting of priorities for establishing scientific attaché positions. A choice between the two agencies was never made. The question was resolved in August 1971 by the dissolution of the Science Secretariat and the creation of the Ministry of State for Science and Technology. MOSST, External Affairs, and IT&C would now share the principal burden for planning, controlling, guiding, and coordinating Canada's intergovernmental scientific and technological activities. Clear allocations of specific responsibilities, however, took time to evolve.

The Creation of MOSST

Studies of science policy in Canada by both the OECD in 1969 and subsequently by the Lamontagne Committee (Senate Special Committee on Science Policy) had favoured the establishment of a science portfolio. The existing policy structure had not been effective in advising Cabinet, and the new Ministry of State concept appeared to fit the need for centralization of science policy efforts. MOSST was established to improve the formulation and coordination of policy in science and technology, including international science and technology. The ministry's extremely broad, horizontal mandate embraced a provision for "the fostering of cooperative relationships . . . with other nations." MOSST would also "assist" departments in the development of policy advice "with regard to the extent and nature of Canada's participation in international scientific activities and the coordination of related domestic activities."[4] Clearly, the new policy structure no longer neglected the international dimension. But the misunderstandings that arose over the degree to which the mandate might have granted an operational, as opposed to an advisory, role for MOSST in the international sphere initially created conflict and confusion.

Interdepartmental conflict occurred at a number of levels. MOSST'S attempt to establish its role created difficulties not only between MOSST and External Affairs, and MOSST and IT&C, but between MOSST and the science-based agencies on foreign policy as well as domestic questions. In addition, External Affairs' relations with the science-based agencies have not always proceeded smoothly. As one analyst of international science policy recently observed, when the impact of science and technology on central political issues became obvious and "ministries of foreign affairs tried to secure more significant participation and control over national involvements and commitments," other departments had already constructed "a tradition of international responsibility . . . which they were quite unwilling to yield." These bureaucracies,

> "tend to question the wisdom of turning over science and technology matters from the hand of the expert to the hand of the generalist, and they are also apprehensive of the interference of foreign policy goals with the rationality of their missions. They usually show little understanding for the argument that only ministries of foreign affairs have the necessary overview to evaluate the respective merits of competing priorities."[5]

The problem is illustrated by the changing pattern of NRC exchange agreements. When NRC assumed the responsibility for scientific liaison with the Soviet Union in 1959, for example, there seemed no question that this was a

proper NRC function. By 1969, however, evolving government attitudes with respect to the diplomatic significance of scientific cooperation had produced an NRC agreement with the Quai d'Orsay, which NRC came to regard as scientifically unsatisfactory. In addition, as part of the Trudeau government's commitment to improving the process of foreign policy decision making, "a major expansion in the resources and roles of the foreign affairs components of various domestic departments" was encouraged.

> "These departments were given direct authority over the international aspects of their national activity and allowed to establish internal units to act as focal points for foreign-related matters. The transfer of External Affairs officers to these new units provided the units with competitive diplomatic expertise as well as specialized functional skills. And a government doctrine defining foreign policy as the extension abroad of domestic imperatives legitimized the role of these units as the coordinative linchpins and advisory mainsprings of the Canadian foreign policy process."[6]

Despite some difficulties brought on by the expanded international roles of most science-based agencies, the major problems did not develop between these departments and External Affairs, but between all departments and MOSST. The Ministry's initial trouble in establishing productive working relationships with the mission-oriented departments was examined in a Science Council background study.[7] In concurring with the authors' assessment, one Minister of State for Science and Technology subsequently observed that there had been "no obvious fields of decision-making responsibility [for the ministry] to step into. Whatever it did was likely to transgress the boundaries of other departments and agencies." In developing its advisory and coordinating role, he conceded, "mistakes were made . . . . MOSST had perhaps too high a public profile and tended to make public pronouncements on matters that concerned other departments . . . . There was also a temptation to take on everything at once and not concentrate the limited resources of the Ministry on a few important tasks."[8]

This judgement is as applicable to MOSST's relations with External Affairs in the first three years of its operation as it is to MOSST's relations with the other departments. It helps to explain the lack of rationality that sometimes characterized the proliferation of intergovernmental science and technology relationships in the early 1970s, and some of the difficulties that were encountered in planning and implementing exchanges. In the international field, the creation of MOSST had the effect of diminishing the government's coordinating capacity instead of strengthening it, as intended.

MOSST's "temptation to take on everything" in international science and technology led External Affairs to conclude that the new ministry was attempting to create its own science-based foreign service.[9] In a number of areas, responsibilities appeared to overlap, leading to bureaucratic frustration, time-consuming disputes, and costly duplication of effort. The irritations that developed hindered interdepartmental consultation and, in External Affairs' view, consultation was imperative. The development of science and technology relations with countries like China and Japan, or the selection of embassy science counsellors, required the established expertise and political perspective that External Affairs possessed but MOSST did not. The science-based agencies similarly complained of inadequate consultation. For example, the MOSST-initiated mission to China apparently resulted in some exchanges that were of questionable value to Canada because the technical departments had not

really been involved in the planning. The departments were also concerned with MOSST's incursions into their areas of international scientific responsibility. Conflict that emerged between MOSST and NRC, for instance, and MOSST's apparent disinclination to see NRC develop additional international contacts may have delayed unnecessarily the signing of an NRC Exchange Agreement with the Japan Society for the Promotion of Science.

External Affairs and the science-based departments viewed much of MOSST's international activity as part of the Ministry's effort to maintain a high public profile. Thus they tended to criticize MOSST for being more interested in seizing initiatives, via the well-publicized sending and receiving of science and technology delegations, than with following through on them. Cautious preplanning for the careful conservation and allocation of MOSST and other government resources did sometimes seem to be lacking. A request from MOSST for follow-up exchanges might easily bring the complaint from the science-based agencies that they were already overextended in carrying out existing commitments. On the other hand, the absence of an immediate follow-up to a scientific mission would be interpreted by External Affairs as potentially damaging to the overall course of relations with a particular country. Clearly, interdepartmental cooperation needed to be improved. By late 1973, the departments had recognized that the uneasy relationship between MOSST and External Affairs and between MOSST and the science-based agencies was having a negative effect on decision making and operational activity, and that a more flexible approach was required. The growing number of Canada's international science and technology involvements also seemed to demand, in particular, the development of a structured interdepartmental mechanism to hammer out overall policies and priorities and coordinate programs and plans.

Organization: 1974 to Present

Existing mechanisms for interdepartmental consultation in the area of international science and technology planning had been designed to serve specific policy requirements: for example, External Affairs chaired an Interdepartmental Committee on the Environment, the Visits Panel (which had been organized when it became apparent there was a need for special machinery to handle the political and security implications of exchanges between Canada and communist countries) and, later on, an Interdepartmental Committee on the Specialized Agencies of the UN. Similarly, an Interdepartmental Committee on Space (ICS) was created to formulate a space policy and to devise a response to the American proposal that Canada participate in the post-Apollo program. Otherwise, throughout the period of most rapid expansion – the development of science and technology relationships with China and Japan and the signing of "umbrellas" with Russia, Germany, and Belgium – interdepartmental coordination proceeded on an *ad hoc* basis. No mechanism existed for comprehensive planning or for provision of an overview.

An initial step toward improving interdepartmental discussion and coordination was the establishment in 1970 of the Interdepartmental Committee on External Relations (ICER). This committee was set up in recognition of the fact that almost every agency of the federal government was involved in some form of international activity, and that the activity was increasing in both scope and complexity.[10] However, ICER was expected to deal with a wide variety of policy questions, and international science and technology

represented only one part of its spectrum. In early 1975, therefore, an even more specialized group was formed – the Interdepartmental Committee on International Science and Technology Relations (ICISTR). The Committee is chaired by External Affairs and its participants include MOSST, NRC, AECL, IT&C, EMR, Statistics Canada, and the Medical Research Council, as well as the departments of Health and Welfare, Agriculture, Indian and Northern Affairs, Environment, Transport, and Communications. Other interdepartmental committees like ICS retain the coordinating function for their particular policy area, but the government's overall policy and participation in international science and technology is now coordinated through ICISTR and its various subcommittees. These latter working-level groups are responsible for dealing with ongoing operational activities – the development, for example, of relations under an existing agreement or within a particular multilateral organization. The Committee as a whole meets approximately three times a year to coordinate activity in the broader sense, and to discuss and formulate policy in a major issue area of either sectoral or geographical interest. Although ICISTR has no secretariat or research staff, the Committee has been reviewing or is planning to review Canada's science and technology relationship with the Soviet Bloc, the OECD countries, and parts of the developing world, as well as international activities in such sectors as information science and computer applications.

ICISTR provided a badly needed forum for the general discussion and harmonization of Canadian participation in international science and technology, but interdepartmental coordination was additionally strengthened by the 1974 reorganization of MOSST. Under the leadership of a new minister and secretary, MOSST abandoned its attempt to develop an operational function and External Affairs assumed the lead role in the management of Canada's international science and technology relations. The latter department undertook the primary responsibility for coordinating the administration of bilateral agreements, sending and receiving missions, and organizing conferences, visits, and participation in multilateral committees. External Affairs was also charged with ensuring the follow-up to these and similar activities, selecting the science officers for posting abroad, and providing interdepartmental and federal-provincial liaison. MOSST retained only its advisory capacity, considering itself "responsible for developing appropriate policies in relation to international science matters," particularly where the issues transcended the interests of a single line department, and for providing leadership "where appropriate" for delegations to international scientific conferences.[11] MOSST would also seek to build and maintain an information base on scientific and technological activities outside Canada and keep science counsellors at Canadian embassies "up-to-date" on Canada's science and technology programs, policies, and priorities.

For most countries, the emergence of science and technology as an increasingly important factor in international relationships placed a strain on the policy-making apparatus of federal governments. Bureaucracies are slow-moving by nature and organizational changes designed to cope with the new phenomenon required time. In Canada's case, the evolutionary process was made more complex by the search for an overall science policy mechanism – by the setting up of the MOSST experiment. The restructuring of MOSST, a clearer definition of department responsibilities, and the establishment of interdepartmental consultative machinery have all contributed over the last

few years to a more rational and coordinated Canadian government effort.

Nevertheless, serious problems remain. The designation of External Affairs as the dominant department raises the question of institutional continuity. Foreign service officers, whether assigned to geographical or functional desks in Ottawa, are subject to rotation. Thus officers in the Scientific Relations division seldom hold their positions for more than three years before they are posted abroad, and the shift generally occurs much more frequently. The Scientific Relations desk has probably had a greater number of continuing contacts with other departments and agencies of the federal government than any other bureau in External Affairs. The smooth functioning of this liaison is essential to the integration of foreign policy with scientific goals, and is a necessary prerequisite for adequate coordination. Frequent changes in personnel may disrupt cohesion. Personnel changes also tend to complicate the already difficult problem of merging political skill with scientific understanding. As the Science Council pointed out in 1973, more thought should be given to creating "overlapping competencies" for diplomats dealing with science and technology, as well as for scientists working in the international arena.[12]

Competence, both in terms of operational effectiveness and policy development, also seems jeopardized by recent organizational changes within External Affairs. In the latter half of the 1960s, foreign policy decision makers tended to view international science and technology as an off-shoot of cultural affairs. A decade later, Canada's external relations in this area have not gained much intrinsic importance. International science and technology is now regarded as merely one aspect of economic policy – a subset of "trade and aid." A mid-1977 reshuffling of bureaux within External Affairs' economic division therefore resulted in a reallocation of responsibilities from the Scientific Relations and Environmental Problems office to numerous other functional and geographical desks. Scientific Relations now serves primarily in an overview, planning, and liaison capacity. The bureau continues to handle Canada's multilateral commitments, but the coordination of many issue-oriented concerns, such as energy policy, and of most bilateral activity is currently diffused throughout the Department. An official in a science-based agency, with responsibility for the administration of his department's participation in exchanges with four or five countries, could find himself trying to synchronize policy with External Affairs through an equal number of geographical bureaux. The rationale, of course, is that science and technology relations should be treated as one part of a whole bilateral association, but from the standpoint of a coherent external science and technology policy, the Department's most recent reorganization represents an unfortunate step backward.

If External Affairs is to build competence and hence maintain credibility in this key area, then some basic changes in attitude will be required. International science and technology must be recognized not only as an instrument for the promotion of commercial relations or as a tool for development assistance, but as a policy area of ever-increasing national and global significance. As the US Department of State concluded in a 1973 internal reorganization study, science and technology are "inherently international in scope and impact," and will continue "to grow in importance for diplomacy." The conduct of external relations requires "a vigorous focal point for science and technology, especially for interagency cooperation, policy development, and interpretation of technological issues and options."[13] External Affairs needs

such a focal point. Primary responsibility for science and technology relations, both bilateral and multilateral, should rest in a single organizational unit. The creation of such a unit, preferably with permanently assigned and hence well-seasoned and experienced staff, would go far to support External Affairs' authority and legitimacy as the lead agency in the conduct of Canada's international scientific and technological affairs.

To achieve a "better combined expertise" policy makers also need a centralized information service.[14] Establishing a complete inventory of the bilateral and multilateral involvements that require External Affairs' participation would be a sufficiently arduous task, but the difficulty is compounded by the fact that a great deal of science and technology cooperation proceeds on an interagency basis. External Affairs is not always informed of visits from foreign scientists unless they need to be handled through the Visits Panel. The departments are not obliged either to keep External Affairs abreast of joint projects and programs, or to provide follow-up data on departmental missions and exchanges. This fragmentation of science and technology relations on the basis of scattered sectoral concerns makes it very difficult for the dominant policy maker to assess accurately the scope of a particular international relationship, or to evaluate properly its profitability. The government's monitoring capacity has improved somewhat with the creation of ICISTR, but the Committee is primarily concerned with providing an overview, and gathers information only on issues that are of general, interdepartmental interest. Substantive inventories lie outside the Committee's present scope. Filling the information gap in the policy-making structure would require the cooperation of ICISTR departments. Securing their assistance could be difficult since many of the departments do not appear to maintain comprehensive inventories of their international activities, even for departmental purposes.[15] Nevertheless, the need is pressing and once a system is set up, the job might seem less onerous. As the lead department, External Affairs would seem to be the appropriate agency for assuming the responsibility. On the other hand, some of the science-based agencies might be more willing to cooperate if the data gathering body were ICISTR, a group which also represents their interests.

Besides the question of institutional continuity and competence and the problem of an information gap, policy makers are currently confronted with another difficulty. Before the proliferation of intergovernmental agreements and exchanges, Canadian participation in international science and technology had always been funded by the line departments, which had established relations with their counterparts abroad in order to pursue their own goals. Each science-based agency was responsible for financing its own agreements out of its own budget. As early as 1969, however, the Science Secretariat had recognized that if departmental involvement were to be required on the basis of broader national objectives, in support of diplomatic or economic necessity, a central funding system might have to be set up. Special temporary financing has sometimes been arranged – to support, for example, some exchanges with France, Russia, and China – but no permanent central fund has ever been established. The absence of such a fund, officials initially argued, would impose a certain discipline on the line departments. It ensured that departmental proposals for cooperation under intergovernmental agreements would serve departmental priorities as well as national interest, for the greater benefit of all. On the other hand, some of the science-based agencies insisted from the beginning that individual departmental priorities were not likely to be served

by exchanges with most countries, and accumulated experience has tended to buttress that view. In addition, the problem has been exacerbated over the last few years by the government's fiscal restraint program. Budget cuts have undermined existing departmental willingness to undertake cooperative programs of minimal scientific value but of substantial political significance. The developing reluctance to deploy limited resources on international exchanges that are not of direct departmental benefit has had an effect on the implementation of agreements. Throughout the remainder of this study the funding dilemma will be a recurring theme.

III. Bilateral Science and Technology Agreements

III. Bilateral Science and Technology Agreements

Since the end of World War II, Canada has either signed, or is about to sign, more than 80 bilateral agreements in areas related to science and technology. This figure excludes regulatory arrangements such as an agreement on uranium safeguards, the numerous technical assistance agreements with nations in the developing world, and the various defence R & D arrangements with the United States. In reviewing the agreements made, the following classification system has been adopted:

Type I – General agreements for cooperation in science and/or technology;

Type II – Economic or cultural agreements which include provision for cooperation in science and/or technology;

Type III – Agreements in specific scientific or technological fields or covering particular projects;

Type IV – General exchange or cooperation agreements between specified science agencies.

Out of the 81 agreements listed in the Appendices, there are only four Type I agreements, and seven in each of the Type II and Type IV classifications. The overwhelming proportion, the remaining 63 agreements, fall within the Type III project- or area-specific category. This category encompasses all of Canada's science and technology agreements with the United States, and over two-thirds of the agreements with other countries.

Formal bilateral agreements may take the form of treaties, exchanges of notes, exchanges of letters, or memoranda of understanding, but all impose some kind of obligation on Canada. They are written expressions of intent, on the part of the Canadian government or a Canadian government agency, to cooperate with a foreign government or a foreign government agency in a scientific or technological capacity. Agreements, in whatever form, may be either intergovernmental or interagency in status. Interagency agreements may cover cooperative arrangements at the technical level between Canadian government departments and their counterparts abroad. They facilitate the development of close working links with foreign agencies and can be negotiated without necessarily involving the Department of External Affairs. On the other hand, interagency agreements may also be negotiated by External Affairs without necessarily involving other departments. One of Canada's Type I agreements, for instance, took the form of an Exchange of Letters between the External Affairs Minister and the Yugoslav Foreign Secretary. It is a written expression of Canada's intent to encourage additional contacts and cooperative exchanges, and is therefore classified as a general science and technology agreement. It contains no reference to a science-based agency, but it is interagency in status, and therefore does not require publication in the Canada Treaty Series (CTS). Slightly less than half the Canadian-American agreements listed in Appendix B, and about 40 per cent of those concluded with countries other than the United States, are interagency in nature.

An interagency agreement is raised to the status of an intergovernmental agreement whenever significant policy implications or legal factors come into play. For example, the 1971 Communications Technology Satellite Agreement between the Canadian Department of Communications and the US National Aeronautics and Space Administration was accorded intergovernmental status because of its importance to the development of space technology and satellite communications systems in Canada, and because the arrangement needed a clause governing settlement of third-party claims. Where foreign or domestic

policy considerations intervene, or where legal considerations are paramount (liability provisions, substantive financial obligations, the conferring of a right on one state to carry out activities on the territory of another), the working-level relationship is transcended and a binding commitment between governments is required. The choice of an intergovernmental over an interagency agreement may also be dictated by the requirements of political organization in other countries. Thus intergovernmental accords will be found within every category of Canadian science and technology agreements. Even the Type IV classification produces one – the Exchange of Scientists Agreement between the National Research Council and the Conselho Nacional de Pesquisas of Brazil. This interagency understanding is intergovernmental in status and was published in the Canada Treaty Series.

Types I and II

Of the 11 agreements that fall within Type I and II categories, eight may be subclassified as intergovernmental "umbrella" or "framework" accords. Frame work agreements derive their name from the formally structured mechanisms they encompass, mechanisms set up to facilitate and assure science and technology cooperation. These mechanisms generally take the form of high-level mixed commissions or joint committees which meet regularly to assess cooperative activities, review programs and proposals, and oversee the work of the various subcommittees and working groups that may also be established. Three Type I agreements adopted this style of operation: the general science and technology agreements with Belgium and with the Federal Republic of Germany, and the Industrial Applications Agreement with the Soviet Union, all signed in 1971. Five Type II agreements with provision for science and technology cooperation also assumed the umbrella format: the cultural accords with France and Belgium, the General Exchanges Agreement with the Soviet Union, and the Agreements for Economic Cooperation with Japan and the European Community (EC), signed in 1965, 1967, 1971 and 1976 respectively. The science and technology provisions of the 1967 Belgo-Canadian cultural accord were supplanted by the 1971 general agreement on science and technology. Thus Canada is currently concerned with the implementation of seven "umbrellas" embracing some form of joint scientific or technological cooperation – two with Russia and one each with France, Germany, Belgium, Japan, and the EC.

In Canada, the umbrella format was developed in the early 1960s and found its first expression in cultural exchange agreements. Policy makers viewed the establishment of the mixed committee structure as a necessary impetus to effective implementation. By scheduling regular joint reviews of activities under an agreement, both countries would be encouraged to carry out its provisions and stimulated to come up with new proposals. Problems would be more easily resolved and interactions would be meaningful and substantive. As Article 9 of the 1967 Belgo-Canadian Agreement states:

> "In order to establish direct continuous consultation with each other in the field of cultural relations, and in order to ensure the implementation of the dispositions falling within the framework of the present Convention, the Contracting Parties shall establish a permanent Joint Committee which. . .shall meet in plenary session at least once every two years, in each country alternatively."[1]

The adoption of the joint committee framework as a means of ensuring the smooth functioning of cultural agreements, or of Type II agreements which combined culture with education, science, and technology, was certainly not unique to Canada. The United States, the United Kingdom, and France, for example, had undertaken a number of such agreements before Canada had concluded one, and these countries among many others had also moved more quickly in evolving Type I agreements of a similar format but pertaining solely to science and technology. Canada signed its first Type I umbrella with the USSR in January 1971. By that time, the United States had concluded bilateral science and technology agreements with Japan, Germany, India, Iran, Australia, Romania, Taiwan, and Spain. In addition the nations of Western Europe had a dozen or more in force with each other or with countries in the Soviet Bloc.

The motivations underlying the international proliferation of both Type I and Type II umbrellas varied, of course, according to the individual needs of the countries involved. Some general considerations, however, at least among the nations of the industrialized West, appear to have been rather universally applied. The Bureau of International Scientific and Technological Affairs within the US Department of State noted these considerations in its 1970 analysis of American bilateral programs. The diplomatic purpose of science and technology agreements, the Bureau observed, is "to provide tangible evidence of rapport between the two participating countries, especially on the occasion of a meeting of their political leaders" and, additionally, "to increase the interaction among their peoples in a professional and non-controversial field." The scientific purposes are "to support the principle of pooled expertise and exchange of knowledge." The State Department agency perceived a number of "built-in advantages" in formal bilateral agreements, including the impetus they provide for cooperation that might otherwise never occur. By focussing on and publicizing opportunities for collaboration, an agreement supplements the random and haphazard exchange process that depends on "accidental coincidence of interest, acquaintanceship, etc. An international agreement forces a more searching and systematic review of potential cooperation." Moreover, by calling the attention of government officials to the scientific community, and by providing scientists at home with the opportunity to interact with their outstanding counterparts abroad, an agreement enhances the visibility, stature, and prestige of local scientists. According to the Americans, formal science and technology agreements also increase governmental support for the scientific community, and greatly expand and facilitate the possibilities for exchanges of personnel, materials, and information. The one qualification in the 1970 report was the observation that political purposes are "unlikely to be well-served unless there are substantial scientific benefits to be shared."[2]

In 1970, Canadian policymakers would have concurred with the American evaluation. As planning advanced and as negotiations proceeded toward the 1971 conclusion of the four umbrellas with Belgium, Russia, and Germany, Canadians expressed similar views concerning purpose and anticipated benefit, along with other important considerations based on uniquely Canadian perceptions and needs. But five years later, Canadian officials might also have concurred with another American report that now pointed to an unfortunate number of marked disadvantages in bilateral science and technology agreements. In light of the accumulated American experience with the 28 or more

bilaterals negotiated between 1961 and 1974, a Congressional study concluded in 1975 that "agreements are easy to make, costly and time-consuming to implement, difficult to keep track of, duplicative in effects, and painful to terminate."[3] An in-depth look at one Canadian umbrella will suggest the applicability of this statement to the Canadian experience, and explain the shift in the government's attitude over the last decade with regard to the general value of Type I and II framework accords.

The Case of the Umbrella Agreement with Belgium

Origins

The Type II cultural agreements which the Pearson government signed with France in 1965 and with Belgium in 1967 were, as Peter Dobell stated, "defensive actions" taken internationally to counter a domestic threat. The strengthening of ties between Quebec and France in the early 1960s, and the concomitant diminution of communication between Paris and Ottawa, and Ottawa and Quebec City, had compromised the integrity of the federal government. The French agreement was concluded in part as an offsetting mechanism – as a way of bringing Franco-Quebec exchanges under federal supervision and of asserting Canada's sole jurisdiction in international relations. Contacts were already pervasive, however, and as Dobell noted, they "soon began to multiply without the federal government having the means of controlling their extent or even their character." By signing the 1967 agreement with Belgium, therefore, the government sought "to forestall any possibility of the development of similar difficulties" with the other French-speaking nation of Europe.[4] In establishing a framework for expanded cultural, artistic, scientific and technical relations with the Belgians, Ottawa hoped to be able to confine Belgo-Canadian exchanges to those taking place at the federal level.

A preparatory conference prior to the first meeting of the Belgo-Canadian Mixed Commission was held in Brussels in December 1969, but before that time, Belgium and Canada were already considering the idea of separating scientific and technical cooperation from cultural exchange. The proposal for a second umbrella, focussed solely on science and technology, was a Belgian initiative broached for primarily scientific and technological reasons. Canada's response was dictated by primarily political considerations. The origins of the 1971 agreement, broadly stated, lie within a renewed emphasis on the part of the Trudeau government on "national interests" as the significant criteria in the development of foreign policy goals and priorities. Within the hierarchy of national interests, the prime minister included the paramount one of the ensuring "the political survival of Canada as a federal and bilingual sovereign state."[5] As subsequently stated in the White Paper on foreign policy, the government viewed,

> "Canada's relations with French-speaking countries in Europe. . .[as] particularly significant in the context of strengthening national unity and reflecting in foreign policy the bilingual nature of Canada. The Government has given high priority to cultural relations [and] . . . is making solid efforts to develop . . . scientific and technological cooperation."[6]

The search for an enhanced symmetry between national objectives and international activities, and the closer integration of certain domestic realities with foreign policy decision making led to the science and technology umbrella with Belgium.

Belgian interest in developing a strengthened science and technology relationship with Canada derived from the preoccupations of the Belgian Science Policy and Planning Service (SPPS) and its minister, Théo Lefèvre. M. Lefèvre had been prime minister from 1960 to 1964, and upon assuming his post as *Ministre de la politique et de la programmation scientifiques,* he set out to broaden the basis for cooperation with Canada. Indeed, Belgo-Canadian cooperation was a matter, Lefèvre subsequently wrote, "qui a retenu toute mon attention depuis que j'ai accepté la responsabilité de la politique scientifique belge."[7] As the first expression of his concern, Lefèvre sent a scientific delegation to Canada in October 1968 under the leadership of Dr. Jacques Spaey, SPPS secrétaire général and chief science adviser to the Belgian government. The subject of increased cooperation was raised again later in 1968 and 1969 during the separate visits to Ottawa of the Belgian Foreign Affairs Minister and the Minister of Foreign Trade. Then in December 1969, Lefèvre issued an official invitation to the Canadian government for a Canadian science and technology mission to visit Belgium.

In conversation with Canadian officials, the Belgians strongly emphasized their interest in the exchange of industrial technology. Belgium, like other European nations, had recently taken cognizance of the "technology gap," and was less than satisfied with the generally indifferent attitude of the United States toward the problem. The Americans had apparently not been interested in technical collaboration with the Belgians. In fact, while the United States had inaugurated science and technology programs with Germany, Italy, France, and Spain in 1966, 1967, 1969, and 1970 respectively, no similar program with Belgium ever emerged. Thus M. Lefèvre and his ministry pressed for a science and technology agreement with Canada as a means of helping Belgium secure access to North American technology. Such an agreement would fit in with the SPPS policy of promoting international exchanges in aid of Belgian development, particularly in fields related to national R & D priorities. Early in 1970, before a Canadian science and technology mission was organized and sent to Brussels, Lefèvre himself visited Ottawa. His purpose was to follow up the contacts made by the Spaey delegation in 1968 and, in Lefèvre's words, *"d'arriver à cette compréhension intime des problèmes et des hommes, indispensable à un accord durable."*[8] Between 31 January and 7 February 1970, Lefèvre held discussions with Prime Minister Trudeau, then External Affairs Minister Sharp, Senator Lamontagne, and a number of senior officials from different departments with responsibilities in the scientific area. Accompanied by Dr. Spaey, the Belgian minister also travelled to Quebec City and Toronto to meet with provincial and university officials.

Belgium's concern with industrial technology and provincial and university participation in exchange planning was reflected in the varied composition of the Canadian mission that left for Brussels four months after the Lefèvre visit. Headed by a senior assistant deputy minister from the Department of Industry, Trade and Commerce (IT&C), the delegation also included the director of IT&C's Office of Science and Technology – the division responsible for the concomitant planning of a Russian industrial exchanges agreement. Other delegates represented the departments of External Affairs, Communications, and Energy, Mines and Resources, as well as the National Research Council and the Science Secretariat. Sherritt-Gordon Mines, ATCO Industries, Sicard Incorporated, Surveyer, Nenniger & Chênevert Limited, and Microsystems International represented the business community. Ontario sent its Deputy

Minister of Trade and Development and Quebec sent an official from the Department of Industry and Commerce. The university community was represented by the head of the School of Business at the University of Western Ontario, and by the Director of the Institute of Scientific Research at the University of Quebec. From 8 to 13 June 1970, the 16-man mission investigated the potential for cooperation in a number of areas and concluded that the probability of achieving practical results was quite high. During the visit, a Memorandum of Understanding was signed, "affirming the interest of both countries in the conclusion of a science and technology agreement."[9]

Canadians were aware of the fact that the success of an agreement would depend upon truly effective collaboration, and that involvement on a make-work basis must be avoided. They were aware, too, that the Belgians would probably have less to offer in the purely technological sense than their larger European neighbours, but felt that Belgium would make up in will and enthusiasm what it lacked in size and scientific capacity. Officials were hopeful that the government's industrial incentive program could be broadened to include joint enterprises by Belgian and Canadian companies, and that the appointment of a science counsellor to the embassy in Brussels would enhance the development of sound programs. They also expected cooperation with Belgium to serve as useful experience and precedent for the evolution of similar links with other countries in Europe. A Belgo-Canadian agreement would conform with the Trudeau government's effort to strengthen ties with Europe as a means of countering the overwhelming influence of the United States, and to improve Canadian trade in manufactured goods with the Common Market countries through a bilateral approach to its member nations. Moreover, Belgium was an important source of foreign investment in Canada and was fourth in rank among European trading partners. Its internal bicultural structure also suggested special affinity. Above all, Belgium was a French-speaking country. The strengthening of Belgo-Canadian relations was a vital part of the plan to develop closer Canadian links with the francophone world.

From the domestic political standpoint, a positive response to Belgium's initiative seemed essential. The Belgians had been so fervent in their approaches to the Canadian government from 1968 to 1970, and so intent on securing an agreement that a negative decision might have a damaging effect. The impact might be felt not only on Belgo-Canadian relations and on Canada's position within *la francophonie,* but also on Canada's internal political situation. If Canada did not sign a science and technology umbrella with Belgium, then perhaps Quebec would. Moreover, Quebec had been unwilling to participate in the earlier cultural agreement. In this case, the provincial government had been officially consulted, Peter Dobell noted, only "a few days before" the 1967 agreement had been scheduled for signature. "In retaliation," Daniel Johnson, then Premier of Quebec, had declared that he would boycott a dinner for Prince Albert of Belgium at Expo in Montreal. Only through the personal intervention of Prime Minister Pearson had Johnson been persuaded to change his mind.[10]

In considering a science and technology agreement, the Trudeau government did not repeat the Pearson government's mistake. Lefèvre's visit to Quebec City and Quebec's government, industry, and university involvement in the Canadian science and technology mission to Brussels indicate federal-provincial consultation in the earliest stages, and a determined effort on the part of the Trudeau government to bring Quebec into at least one federal ex-

change program with Belgium.

The agreement was signed in Brussels on 21 April 1971 by the Belgian Foreign Affairs Minister, Science Policy Minister Lefèvre, and External Affairs Minister Sharp, on the occasion of the Governor-General's visit to Belgium. The agreement was described by External Affairs as a "general" one, providing a "framework for cooperative activity . . . in the fields of pure and applied science and technology, and in industry. Cooperation will be undertaken by means of visits, exchanges, conferences and symposia, and joint ventures." A Mixed Commission would meet every year "to review existing activity and to recommend programs." The agreement was to remain in force until April 1976, and then be renewed automatically for two-year periods unless rescinded by either party six months before the projected expiration date.

> "The agreement between Canada and Belgium is the first of its type. It illustrates the commitment of the Government to increased inter-governmental cooperation in science and technology, and the importance Canada attaches to cooperation with Belgium, a bilingual country with an active science community, a dynamic economy and rich and varied academic traditions. The programs envisaged under the agreement are broad enough to allow the scientific, industrial, and academic communities to participate. . . ."[11]

The government now had to embark on the task of making the agreement work.

Implementation and Results

Until the Ministry of State for Science and Technology was established in August 1971, the Science Secretariat had acted as the *ad hoc* liaison centre for the planning of activities under the umbrella. After that date MOSST became the lead coordinating agency. Acting in concert with its Belgian counterpart, SPPS (Science Policy and Planning Service), MOSST made the arrangements for the first Mixed Commission meeting, held in Ottawa in 1972. This meeting was primarily exploratory in nature, since no specific proposals had yet been generated. The delegates were able to define only some general fields of mutual interest. By the time of the 1973 Mixed Commission meeting, held in Brussels in early December, 36 separate topics had been identified as potentially useful areas for exchanges between government agencies, industries, or other organizations. The topics selected in the industrial technology sector included electric power generation and transmission, fibre optics and lasers, ammonia and propylene oxide production, asbestos-based products, metal-forming technologies, computer graphics, welding techniques, solar energy, and automation and pollution control in the steel industry. In the environmental sector, water-resource management, air pollution, oil-spill countermeasures, and solid-waste management were added to the agenda. Other subjects were included in the public health, agriculture, social science, and information science sectors. In a few instances, this resulted in an exchange of experts, an exchange of documents, or at least promoted new contracts between participating organizations. In not one case, however, were Canada and Belgium able to stimulate a joint project of any kind.

In its 1975 review of progress, the third Mixed Commission admitted that efforts in the industrial technology sector – the area of most vital concern to Belgium – "had not achieved much success, mainly because of problems connected with industrial policy, intellectual property and the secrecy

maintained in industry and commerce."[12] For example, in trying to spur a technical exchange between a Canadian company and one of its Belgian counterparts in the housing construction systems field, IT&C was informed that the Canadian firm wished to sell its technology, not exchange it, and that the names of the three Belgian firms suggested by SPPS as potential collaborators were already on the company files. In many other cases, IT&C was simply unable to interest Canadian companies in exploring cooperative possibilities. The businesses involved did not view the potential as sufficient, and were therefore unwilling to invest time or energy in an investigation. A proposed industrial venture in the field of electric power transmission was dropped because of a decline in market conditions. In another case, IT&C had to abandon a proposal because the specific Canadian firm was no longer doing work in that particular field. Of the 13 industrial technology projects identified at the 1973 Mixed Commission meeting, seven were officially dropped by the 1975 Mixed Commission. Four of the remaining were classified as ongoing, but in three cases this meant only that contacts had been established, and in a fourth area – the computer-aided design of mechanical structures – it meant that officials were "still trying to identify areas of mutual interest." Another topic, laser technology, was classified as "hold," although the Commission's report stated that "no mutual interests" had been determined. Finally, the report noted that in the housing construction systems field, the Canadian company was pursuing a "licensing prospect" and that cooperation in that area would now be coordinated by NRC as part of a 1975 Belgian proposal for exchanges in the "industrialization of building construction."

The Belgians came up with seven new industrial proposals in 1975, including suggestions for cooperation in glass and textile technology, plastics recycling, cobalt and nickel-based high-performance alloys, and fire-prevention technology. However, IT&C was able to generate only one potential project – the application of a new Canadian testing method for the enzyme catalase to food technology and medical diagnostic procedures in Belgium. It is clear from the 1975 Mixed Commission discussions that Canadian attempts to improve the prospects for industrial cooperation were resulting, paradoxically, in a shift away from the effort to promote interfirm exchanges. Thus the two countries agreed to make greater use of an approach that would identify "broader areas of research and technology," and hence "explore further the possibilities for cooperation between university-allied research organizations and/or centres for technology."[13] Belgium's new glass technology proposal, therefore, was referred to the Ontario Research Foundation rather than to a Canadian counterpart of Glaverbel, the Belgian glass company which had suggested the topic. Similarly, NRC and other federal government research departments would now have the responsibility for exploring the collaborative potential in other industrial subjects of interest to Belgium.

Cooperative endeavours in other sectors unfortunately fared little better, and seldom amounted to more than an exchange of written materials and an occasional meeting of experts. In the environmental sector, for example, SPPS and Environment Canada exchanged technical reports in the areas of air and oil pollution, and in addition Canada passed on information regarding solid-waste management. On the subject of water-resource management, Quebec sent three experts to Belgium in June 1975, and the two sides "identified gaps in the data needed to develop an overall model."[14] The September 1975 Mixed Commission launched "a second phase of information exchange" in air

and oil pollution, with both sides also remaining "interested in the establishment of a total management model," in the water-resources field. A similar pattern developed in the health sciences sector. Health and Welfare Canada exchanged reference materials with Belgium's *Santé Publique* "on problems related to medical data processing, computerized emergency care, various forms of preventive medicine, and the use of the WHO [World Health Organization] model for health care utilization."[15] Quebec again fielded a delegation, and experts from the provincial Department of Social Affairs visited research and health care institutions in Belgium in January 1975. As a result, Quebec placed before the 1975 Mixed Commission proposals for the exchange of information and personnel in the fields of toxicology, geriatrics, and emergency care systems.

The 1975 Mixed Commission report also noted that, in the social science sector, Canada and Belgium had "exchanged information on research in social policy and management carried out by the relevant departments in each country," and that on the basis of further "input" a decision would be made "as to whether joint cooperation projects should be undertaken."[16] In the agricultural sector, the Commission observed that Belgium had not included a representative from its Ministry of Agriculture in the delegation to the joint meeting, but that Agriculture Canada would send a "study mission" to Belgium in 1976 "once agreement has been reached on the program for the visit." In the field of energy research, the two sides agreed "to keep each other informed on the progress of their respective national programs, to maintain their bilateral exchange of information . . . [and] to keep the door open on possibilities for cooperation"[17] in a number of areas of particular interest to Belgium, including wind energy, solar energy, and the processing of wastes to produce energy. The two countries also promised future exchanges of materials in the areas of historical conservation, data processing and science policy. Finally, in the information science sector, the Commission cited the pilot project being conducted at Belgium's *Centre de diffusion de l'information technologique et commerciale* using Canadian Techbriefs provided by NRC as an exchange that was "proceeding well" and was expected to lead to "productive collaboration."

Difficulties and Disadvantages

The deliberations of the 1975 Mixed Commission clearly reveal that, four and a half years after its implementation, the Belgo-Canadian accord had produced only a handful of information exchanges, plus a number of pledges for more of the same. These exchanges, both ongoing and planned, could probably have been accomplished without benefit of an agreement. Ties between Canadian scientists and research organizations with their counterparts in the Western industrialized world, including Belgium, were already well developed, and the umbrella did little to supplement existing connections. For example, a Belgian proposal put forth at the 1973 Mixed Commission session in Brussels suggested a meeting of experts to identify mutual interests in investigating the impact of drugs, noxious substances, and pollution on public health. During the week of the Mixed Commission meeting, the Canadian health sciences representative discussed the possibilities with the appropriate officials from *l'Institut d'hygiène et d'épidémiologie.* He soon reported that contacts had already been established with scientists at the Institut through earlier visits of Health and Welfare personnel, and that cooperation might be served better by continuing the exchange of individuals rather than by putting together a

meeting of experts. In any case, the opportunities for cooperation in that particular area appeared minimal because of dissimilarities in the Belgian and Canadian systems.

This instance further suggests that officials sometimes presented proposals without giving them sufficient consideration; and inadequate screening procedures did apparently pose one difficulty. But a number of related problems emerged which help to explain the agreement's lack of productivity. Some of these difficulties seem endemic to the umbrella structure, but others appear to have arisen because of certain characteristics peculiar to the countries involved. In the latter category, Canadians quickly discovered that the rather narrow scope of Belgian science presented a serious impediment to the successful functioning of the agreement. Belgian officials were always able to generate a greater number of proposals than were their Canadian counterparts. Canadian officials were often hard pressed to come up with topics of potential value to Canadian scientists, just as Canadian companies tended to perceive little technological advantage in cooperative industrial exchanges with Belgium. In retrospect, it appears that the 1970 Canadian science and technology mission to Brussels overestimated the likelihood of achieving practical results, and that the scientific basis for joint cooperation was never very substantial.

Even in potentially useful areas, however, cooperation was hampered by bureaucratic machinery which restricted the flow of information. Science policy structures in both countries appear to have impeded effective implementation. Both MOSST and its counterpart, SPPS, were reluctant to allow the full participation of other departments within their respective governments. Initially, Canadian science-based agencies – the agencies best suited to prepare an accurate assessment and matching of national scientific capabilities – were insufficiently involved in the preparation of proposals. The topics brought before the 1973 Mixed Commission read more like a long shopping list of hastily assembled suggestions than a well-prepared set of carefully defined plans. Later, it became difficult for a mission-oriented department in Canada to deal directly with its counterpart in Belgium because most communication was channelled through SPPS. Like MOSST, the limited resources of SPPS were widely dispersed over too many areas. For example, one person in the Belgian science policy agency held all responsibility for coordinating national and international activities in the field of environmental research. Hence it is scarcely surprising that Environment Canada encountered some problems in securing follow-up to Belgium's 1973 proposals for cooperation in that sector. Similar frustrations and delays of this nature, and the concomitant effort needed to gather information and come up with new ideas, contributed to the development of a certain lack of interest on the part of some science-based departments in helping to implement further the umbrella with Belgium.

The Canadian funding dilemma also contributed to the growing indifference. On the Belgian side, SPPS administered approximately 2 per cent of the total government science budget, which it used to further priority R & D programs. Part of this money was used when necessary to support international exchanges, including cooperative activity with Canada. On the Canadian side, however, MOSST had no similar fund and participating departments were asked to assume the entire burden. In face of budget cuts, which accompanied the imposition of the government's restraint program, departments became increasingly reluctant to deploy scarce monies on non-productive exchanges with Belgium. There were too many competing priorities. Quebec, on the

other hand, appeared to have adequate funds for study missions and other endeavours conducted under the umbrella. This fact led some federal policy-makers to worry that Belgium might begin to consider that Quebec was more interested than Canada in pursuing joint activities.

There is no question that the Belgian agreement was expensive. As the US Congressional report pointed out in 1975, "compared with multilateral science arrangements, bilaterals involve larger funding in relation to the level of scientific effort because only two countries share the cost."[18] Apart from the funds expended in providing follow-up to the Mixed Commission meetings, the gatherings themselves were costly. In 1972, 1973, and 1975, Canada fielded very large delegations. In 1975, for example, 13 people represented Belgian interests – the four members of the Joint Commission and nine delegates from SPPS, the Foreign Affairs Ministry, the Economic Affairs Ministry, and the Ministry of Public Health. Canada, because the meeting took place in Ottawa, was represented by an even larger number – 18 people from the federal government and five from Quebec. A member of Quebec's Department of Intergovernmental Affairs sat on the Joint Commission and the province sent four additional delegates. Three representatives from MOSST, IT&C, and External Affairs made up the remainder of the Canadian side of the Joint Commission and 15 other government delegates from those departments, as well as from Health and Welfare, Environment, Indian and Northern Affairs, Justice, Energy, Mines and Resources, Agriculture, and the National Research Council were also in attendance.

The sheer size of the delegations meant not only substantial expense but also cumbersome consultative procedures. Mixed Commission meetings in 1972 and 1973 were essentially three-day plenary sessions, in which scientists from various fields participated in overall talks not always related to their particular areas of expertise. The 1975 meeting more effectively divided the delegates into specialized working groups, but the joint committee structure still seemed too heavy and formal a mechanism for the content of the discussions. Preparations for the meetings also consumed extraordinary amounts of government time. Planning on the Canadian side necessarily began many months in advance, starting with a request from MOSST to the participating departments for a status report on all subjects identified at the last meeting, and for new suggestions on potential projects to be reviewed at the next meeting. A draft agenda was prepared on the basis of departmental response and in light of Belgian interests, ascertained through the efforts of the science counsellor in Brussels. The next step involved submission of the status reports and draft agenda to Quebec and other provincial governments for their comments and additional suggestions. Once the provinces had indicated their interests in terms of participation and further topics, a final agenda could be designed, again in consultation with Belgium. Briefing books were then prepared and delegates selected in time for a last coordinating meeting of all Canadian participants.

This investment in terms of time, in addition to money and manpower, was simply not commensurate with the level of scientific return. Indeed, the scientific value of the accord proved to be so limited for Belgium, as well as for Canada, that the former began to evince signs of a reduced interest. In the American experience, particular bilaterals had been "initiated in a burst of diplomatic enthusiasm only to have it appear subsequently that there was no solid scientific basis for joint action, with the result that the agreement

withered but without being crisply terminated because of the diplomatic repercussions abrogation would invite. Even with some potentially useful agreements, it is possible that a decline in interest would accompany loss of funding support. . . ."[19]

Such an evaluation might well describe the Belgo-Canadian experience. Belgium was undoubtedly disappointed in the fact that the agreement had not produced the anticipated industrial cooperation, and SPPS, like the Canadian bureaucracy, had similarly encountered new budgetary restrictions. A lowering of expectations and diminishing funds may have led to some shifting of priorities and a lessening of Belgian will and enthusiasm. In any case, the build up of implementation problems over the first four years and the growing passivity among government departments on both sides brought the agreement to a state of near stagnation.

Significance

With the transfer of the coordinating responsibility from MOSST to External Affairs in 1975, Canadian officials stepped up their efforts to make the agreement work. Policymakers could not allow the Belgo-Canadian science and technology accord to become moribund because it was politically important. Besides being evidence of Canada's commitment to strengthened relations with the countries of the francophone world, the agreement seemed constitutionally significant. Quebec's willingness to participate in the scientific exchange program offered a stark contrast to the level of provincial activity under the cultural umbrella. The federal government's concerted effort to involve the province in all stages from negotiation through the implementation of the second agreement with Belgium had been rewarded by a positive response from Quebec. Provincial authorities apparently showed an occasional tendency to operate independently, by sending a science mission to Brussels for example, without informing the federal government. But no separate mechanism had yet emerged to allow an exclusively Belgo-Quebec orientation. Thus officials renewed their determination to breathe some life into the accord before its political success could be jeopardized.

This attempt may have involved a re-examination of the time-consuming, costly, and cumbersome mixed commission mechanism. No joint session has been held since the third meeting took place in September 1975. This could suggest a new emphasis on less frequent meetings, and also on meetings that would be restricted in size and function. The key deliberations in various science or technology sectors should take place in *ad hoc* working groups, made up of experts from the relevant science-based departments on both sides who can work informally to shift the activity away from general discussions and toward specific cooperative endeavours. By encouraging direct interaction between interested government departments, and by limiting mixed commission meetings to occasional gatherings of selected officials from overview agencies like MOSST, SPPS, and External Affairs, the agreement might become more productive.

The results of the November 1976 election in Quebec may be presenting new functional difficulties, but as long as Canadian officials regard the Belgian accord as politically beneficial, then some attention should also be directed to the financial problem. The mission-oriented departments have no mandate for carrying out international activities in pursuit of national political goals when these activities are non-congruent with domestic science priorities. Use-

ful exchanges with Belgian counterparts might be more effectively stimulated if adequate funds were provided.

Some of the problems encountered by Canada in implementing the Belgian umbrella were not unique to that particular agreement. Similar difficulties developed with the Type I and II German, Russian, and French umbrellas. The motivations underlying the negotiation of each agreement varied somewhat according to different political or economic imperatives, but the effects were generally the same. In every case, results have simply not lived up to expectations. Officials stated their anticipation that the agreements would contribute, over the long term, to the growth of Canada's scientific and technological capacity. The Minister of Industry, Trade and Commerce, in tabling the German umbrella, told the House of Commons that the science and technology agreement was "similar to those with Belgium and the USSR which we have concluded this year."

> "Its aims are to encourage the exchange of information and research; to facilitate the movement of scientists and technologists; and, through the exchange of knowledge and experience, to contribute to Canada's trade and industrial development and to the growth of our exports of advanced industrial products and services."[20]

By and large, these aims have not yet been fulfilled. The scientific, technological, and commercial advantages have not been substantial. The umbrellas with the Soviet Union can at least be justified by the fact that they are facilitative, for it is usually only by means of an agreement that cooperation with the Russians can take place. In other cases, intergovernmental agreements are clearly not necessary to ensure benefits. Indeed, the formality of the umbrella structure, the oversystematizing of the cooperative mechanism, has tended to hinder productive exchanges instead of easing them as intended.

Type I and II science and technology agreements, concluded over the last 15 years by the nations of the industrialized West, are in many respects merely modern expressions of the nineteenth- and early-twentieth-century treaties of friendship and commerce. In Canada's case, the agreements were additionally formulated within the framework of the Trudeau government's heavy emphasis on the integration of various domestic priorities with the foreign policy process. But the political significance of the umbrellas may be negated over time by their scientific and technological limitations. In recognition of this, and in light of accumulated operational experience, officials have generally resisted the signing of any additional umbrellas. Since 1971, only two new accords have been concluded – the 1976 Type II Framework Agreements for Economic Cooperation with Japan and the European Communities (discussed in Chapter IV). Most policymakers have come to feel that the binding commitment imposed by Type I or II intergovernmental agreements should be undertaken only if there is a history of productive cooperative interaction, and a demonstrated need for a facilitative mechanism to improve the level of exchange and joint endeavour. On the other hand, if there is an overwhelming political reason for a science and technology agreement, then the highly structured mixed commission mechanism should be avoided if possible, and flexibility maintained. Every effort should be made to identify in advance not an all-embracing list of subjects, but a few selected areas that offer real potential for effective collaboration. Canadian officials now generally consider that international cooperation in science and technology is accomplished most readily by informal exchanges of information and visits, directed toward the

mutual understanding of complementary interests and capabilities. If such activity should lead to a joint enterprise requiring formalization for policy, legal, or financial reasons, then a Type III project-specific agreement may be negotiated.

Type III

Of the 81 international science and technology agreements listed in the Appendices, 63 lie within the Type III area- or project-specific category. Of the latter, Canada has one agreement in each of the following fields: Arctic sciences, the environment, metallurgy, public health, and seismology; and two agreements in the area of transportation R & D. Six defence science treaties with Norway (1960), Greece (1962), France (1962), Germany (1964), Denmark (1968), and Sweden (1975) also fall within the Type III classification. A far greater number of agreements in this category pertain to atomic energy. Canada's internationally recognized expertise in nuclear technology has led to the conclusion of 23 atomic energy agreements with countries in the developed and developing worlds (from Australia, Finland, and Switzerland on the one hand, to Argentina, India, and Korea on the other). Most of these cooperative arrangements are intergovernmental in status and have been published in the Canada Treaty Series (CTS). Atomic Energy of Canada Limited has also concluded cooperative agreements with its counterpart bureaucracies in France, Italy, Japan, Taiwan, and the Soviet Union, providing for exchanges of information and other forms of collaboration on an interagency basis.

It is the field of space technology, however, that produces the largest number of agreements in the Type III category. Since 1959, Canada has signed, or is about to sign, 26 space-related agreements,[21] a figure representing almost one-third of Canadian bilateral science and technology agreements in all categories and almost 80 per cent of those concluded with the United States. Given the increasing importance of international space technology, the growing number of its applications, and Canada's ongoing role as a user of space systems, analysis of a Type III agreement will be illustrated by a detailed look at one space accord.

The Case of the Space Shuttle Agreement with the United States

Background: Canada's Space Program

Space technology is clearly global in scope and its effective exploitation requires international cooperation. Indeed, cooperation emerged from sheer necessity, for most countries did not and still do not possess all the technology or the resources necessary for them to carry out national programs on an independent basis. The rhythm of Canadian satellite launches, for instance, is much less than the three or four per year needed to justify the investment of hundreds of millions of dollars in launch facilities. The United States can provide the service at a much more reasonable cost. The history of the Canadian space program is intimately bound up with the close working relationship that has developed over the years with the United States. Canadians appear to have benefited not only in terms of launch services. Much of the technology which became the nucleus of a highly sophisticated national scientific and industrial space capability was gained from the Americans.

Canadian-American cooperation predates all other types of international space collaboration and may even be traced back to the period before World War II. In 1939, for example, the University of Saskatchewan was involved with the University of Chicago in a balloon flight project designed to measure cosmic ray intensities in the upper atmosphere.[22]

Plans for upper-atmosphere research by balloon and then by sounding rocket and satellite accelerated in Canada during the 1950s. The Defence Research Board began the solid propellant R & D program that led to the Black Brant series of high-altitude research rockets, and in 1957, as a feature of Canadian involvement in the International Geophysical Year, sounding rockets became part of Canada's space program. Ionospheric research via satellite started in 1959, with the Canada-United States project that eventually produced the Alouette and ISIS series. When Alouette I was launched in September 1962, Canada became the first nation to join the US and the USSR in space. The Canadian-built satellite was extraordinarily successful. Alouette I went on to gather valuable upper-ionospheric data for over a decade, although it was constructed at a time when most satellites had a useful lifespan of only a few months. Its successor, Alouette II, enjoyed similar longevity and remained in operation for almost ten years following launch in 1965. The more sophisticated and complex ISIS I and II, orbited in 1969 and 1971, maintain that tradition.

The 1969 creation of Telesat Canada marked a shift in emphasis away from scientific satellites to the research and development of communications satellites. Canada had demonstrated support for the concept of a global communications satellite system by becoming, in 1964, a founding member of INTELSAT (International Telecommunications Satellite Organization), but by the end of 1967, the Pearson government had also decided to use satellites for expanded domestic communications. The launching of the first Anik spacecraft in 1972 gave Canada the world's first geostationary satellite telecommunications system. Two more Anik satellites were placed in orbit in 1973 and 1975, and a fourth was launched in December 1978. Operated on a commercial basis by Telesat, the Anik-B series has dramatically improved radio, television, telephone, and data transmission service to the more isolated areas of the country. To further its stated objective of equal access for all Canadians to communications (including new advances like tele-medicine and tele-education), in the early 1970s the Trudeau government also embarked on the joint Canada-United States Communications Technology Satellite (CTS) project. Hermes, the CTS satellite, was launched in January 1976. It is an experimental test vehicle for high-powered orbiting transmitters that could bring currently unavailable telecommunication services to even the most remote parts of the country by the 1980s.

Satellite communications, with ionospheric research, comprise a key part of Canada's space effort. However, Canadians also deploy and are contributing to the development of satellite programs for meteorology, navigation, and earth-resource mapping. The latter field is a satellite application of particular significance for Canada, a nation with a vast land mass, scattered population, and abundant natural resources. The emerging technology of remote sensing from space, to monitor and hence manage those resources, was gained from the United States. By means of a 1971 agreement with the National Aeronautics and Space Administration, the Canada Centre for Remote Sensing (CCRS), an agency created within the Department of Energy, Mines and Re-

sources, developed skills and facilities needed to process the data acquired from the American ERTS/LANDSAT series of earth resource satellites, and to introduce the technology to Canadian users. The rapid growth of Canadian expertise in the remote sensing field, as well as the accelerating pace of the technology, is reflected in a recent spate of international agreements. As noted in Appendix A, CCRS concluded cooperative arrangements with the European Space Agency and with France's *Centre national d'études spatiales* in 1976. An agreement with NASA looking toward the joint development of a global crop inventory system (LACIE), and an agreement on joint development of an experimental ocean dynamics satellite (SEASAT) were signed in 1978.

Canada's Space Industry

Space technology is important to Canada not only because of the country's large area-to-population ratio, rugged climate, and untapped northern and offshore resources, but also because of industrial spin-off. As a result of a decision by the Diefenbaker Cabinet, the technology of both sounding rockets and satellites was transferred from Canadian government laboratories to Canadian industry. Bristol Aerospace Limited of Winnipeg began the development of the Black Brant family of rockets in the early 1960s, and their high level of performance over the years attracted scientific markets in Europe as well as in North America. It is satellite technology, however, that has grown into the most valuable asset.[23] Alouette I was primarily an in-house government project, but the associate contractors in the development of Alouette's successors were the Special Products and Applied Research (SPAR) Division of de Havilland Aircraft and RCA Victor Limited of Montreal. By the time ISIS I had been completed in 1969, these firms "had acquired a solid foundation" and the construction of ISIS II proceeded with the government acting only in a supervisory capacity.[24]

The SPAR division of de Havilland, which became the Canadian-owned Spar Aerospace Products Limited of Toronto in January 1968, also pursued development of the STEM device during the same period. STEM (Storable Tubular Extendible Member), an antennae system first conceived at NRC and flown initially on Alouette I, was subsequently carried on hundreds of satellites. Its unique property of low storage volume compared with extendible length led to a number of other specialized applications, for example, gravity gradient rods, actuators, and structural booms. On the Alouette II and ISIS programs, Spar assumed the responsibility not only for sounder antennae and other mechanical device designs, but also for "complete spacecraft structural layout and design, thermal design, . . . orbit calculations and vehicle dynamic analysis."[25] In 1970, Spar became the major contractor for the CTS program, thereby gaining additional experience in the structural design and development of mechanical subsystems, in mission analyses, program definition, and configuration studies. RCA, Bristol, and SED Systems Limited of Saskatoon also participated in the CTS project, with RCA responsible for most of the electronics design. Spar, with Northern Electric Limited of Lucerne, Quebec, further served as subcontractors for Hughes Aircraft of California, the company that built the Anik series of communications satellites for Telesat.

As a consequence of this involvement in the Canadian satellite program, from Alouette and ISIS through Anik and CTS, Canadian industry established a solid reputation in various areas of space electronics and subsystem design.

The STEM device, in particular, earned international recognition. Some 50 of these structures were used in the Mercury, Gemini, and Apollo manned-flight programs. By the early 1970s, Canadian space companies were exporting not only to the United States, but also to France, West Germany, the United Kingdom, and Japan. Smaller markets were beginning to develop in countries like Brazil and India. In its first 15 years, the Canadian space industry – made up of the four established firms with a major commitment (Spar, Bristol, RCA, and Northern Electric), new enterprises like SED, and a dozen or more component manufacturers "with more than a passing interest" in space products – recorded sales of approximately $150 million, resulting in an average employment of about 700 scientists, engineers, technologists, and support personnel.[26] The acquisition of expertise in space had enabled Canada to build an industrial base in a new high-technology field, and to achieve a capability, as one industry spokesman pointed out, "at least contemporary with that of many other countries and in some aspects . . . ahead." Maintaining that capability, he added, satisfied such articulated policy themes as sovereignty and independence, economic growth, and peace and security, and therefore fitted in with various declared national objectives.[27]

Some space industry officials believed that national objectives might be served even more effectively if Canada developed the capacity to build full space systems. In a brief presented to the government in 1973, the Air Industries Association of Canada (AIAC) argued that "it should not be tacitly assumed" that it would always be possible to procure communications or earth observation systems from foreign sources, and that "control of and continued access to such systems implies Canadian ownership . . . operation . . . and maintenance. Subsidiary benefits . . . would follow in the creation of jobs, expertise, national pride and prestige . . . ." The industry further suggested that it might be time for Canada to break away from its "traditional" economic role "as a nation of raw material and subcontract suppliers."

> "Do we wish to have a space policy reflecting this attitude – one which is dependent on the space programs of other countries – one which involves Canadians mainly as subcontractors to U.S. prime contractors – one which requires Canada to depend on U.S. launch vehicles? . . . perhaps Canada should be undertaking a more national, more independent posture . . . . It may only be a question of developing a national confidence.[28]

Emerging government policy was given a "baptism by ordeal," according to one official, by the decision to purchase the Anik series of communication satellites from an American company, but policy remained that "of achieving subsystem expertise rather than trying to compete with Europe or the US in full systems."[29] Nevertheless, the government did eventually implement two other space industry suggestions. In its 1973 brief, the AIAC had recommended not only a "continuing planned program for the design, construction and operation of domestic satellite systems," but also a "stable program of technological development, contracted out to industry, in respect to certain key subsystems and component activities . . . in which Canadian industry has demonstrated excellence at the international level." The Association further recommended that Canadian participation in international space programs "be expanded . . . on the basis of pragmatic agreements entered into by Canada with its international partners."[30] The latter two proposals came to

fruition in a 1975 Canadian-American agreement for cooperation in the development and procurement of a space-shuttle-attached remote manipulator system. The RMS project, a further development of Canada's recognized excellence in the manufacture of extendible structures, was contracted to a Canadian industrial consortium headed by Spar. It represented a significant expansion of the Canadian commitment to international cooperation in space, and a major contribution to the American post-Apollo program.

The US Post-Apollo Program

Shortly after his inauguration, former President Richard Nixon set up a special Space Task Group to advise the Executive Office on an appropriate course for the United States in the post-Apollo period. The Task Group, completing its report in September 1969, recommended as a primary objective the development of "new systems and technology for space operations with emphasis upon the critical factors of (1) commonality, (2) reusability, and (3) economy. . . ."[31] One of the new technologies to be developed was the space shuttle transportation and research system. The core of the system would be the shuttle orbiter, a reusable vehicle resembling a jetliner, and large enough to transport seven crew members and up to 30 000 kg of hardware into space. In its enormous cargo bay, the shuttle would be able to ferry into earth orbit satellites and their accompanying upper-stage boosters, space probes, a space laboratory, and other scientific equipment. The reduction in expenditure, compared with the cost of conventional launching from earth facilities, and the greater carrying capacity of the shuttle system would mean that bigger, more powerful satellites could be placed in orbit for a more economical price. The shuttle system would also permit satellite repair, either through on-board servicing or by return to earth, which could possibly save multimillion-dollar spacecraft from degenerating into space debris. For scientists, the system would offer an orbiting laboratory with two critical properties that could not be reproduced on earth: a perfect vacuum and freedom from gravity. Each orbiter vehicle would be used up to 100 times, and initial NASA plans called for five of them. The shuttle system, in providing regular, easier, and cheaper access to space, would be the cornerstone for all American space operations at least through the 1980s and possibly beyond.

By internationalizing the program, the Americans also turned the space shuttle project into a key component of the space programs in other nations. The task group had recommended that the United States "promote a sense of world community" in the post-Apollo period, by providing the "opportunity for broad international participation and cooperation." A month after this proposal had received presidential assent, NASA's chief administrator, Dr. Thomas Paine, invited European participation. Speaking before the European Space Conference in October 1969, Paine described American plans, making it clear that the Europeans were being offered "something quite different" from earlier cooperative projects. "It was an offer to participate, not merely cooperate, in the design, development, management, and use of major manned flight systems. No similar proposal had been put forward by the US in the past."[32] On 15 December 1969, Dr. Paine travelled to Ottawa. Addressing a group of interested ministers and other senior government officials, Paine formally invited Canada to participate in the development of a new era in space transportation.

The American invitation to Canada and to other technologically ad-

vanced nations was motivated by more than considerations of potential scientific advantage. There was a strong political rationale. By involving Canada, Australia, Japan, and ten European countries in space shuttle development, officials hoped to make the space program less vulnerable to termination or substantial reduction. According to a US Congressional Report, "many people, including many Members of Congress" saw the walk on the moon as the end, "albeit a glorious one," of United States manned space flight.

> "They were ready to take the billions which had been allocated toward reaching the moon and use them toward a solution of problems on earth . . . . A space program involving international cooperation might be more attractive to the Congress in terms of national prestige and self-image. International involvement in the post-Apollo program could provide stability by necessitating firm commitments . . . . The likelihood of a change in midstream once the forces of collaboration were formalized would be smaller. . . ."[33]

In other words, the possibility of international repercussions would deter Congress from making too many cuts in future NASA appropriations. In addition, international cooperation on this scale enhanced the American identification of its national space effort with the welfare of mankind and the search for world peace. External political considerations were paramount in Nixon's decision to open the program to global participation. The United States might gain much goodwill by a greater sharing of the technological benefits to be derived from the project, and such a course of action could "be a force for strengthening US alliances." Furthermore, given American "competition with the Soviet Union's aggressive manned space program," a scaling down of the US effort in the post-Apollo period would mean political advantages for the Russians. NASA may also have been motivated to internationalize the project for financial reasons, although "media consensus" was that funds saved by sharing R & D "would be negated by the estimated 10 to 15 percent additional costs of collaboration."[34] The space shuttle did prove to be an expensive venture. By mid-1977, about $3.5 billion had been spent on the program, approximately one-half the anticipated total cost for development. The final total for R & D, equipment, and facilities is expected to be around $9 billion.[35]

Space Policy Organization

The whole question of Canada's possible participation in the post-Apollo program was turned over to the newly created Interdepartmental Committee on Space (ICS). The function of this committee, "formed by Cabinet in late 1969 . . . was to advise on policy and planning for the Canadian space activities," and by means of "continuing review and assessment, to ensure the coordinated development of government, university and industrial activities, and international cooperation."[36] In face of an increasing number and variety of space operations, and difficult policy choices posed by new opportunities in emerging fields like remote sensing and in communications technology, many officials thought that the organizational structure needed more than an interdepartmental committee. Government, university, and industry representatives, in briefs presented to the Science Secretariat in 1966, had lamented the lack of a central space agency – a Canadian equivalent to NASA or to France's CNES (*Centre National d'études spatiales*). "The absence of a national mission-oriented agency with overall responsibility for upper atmos-

phere and space activities," according to their testimony, had "resulted in fragmented programs, divided responsibility, and serious omissions in planning." Such deficiencies "could lead to tragic consequences for Canada in loss of technological opportunity . . . . A central coordinating and contracting agency for space research and development" should be established.[37]

The idea of a space agency was dropped and ICS was formed instead as no government department would support the plan. The National Research Council and the Department of Communications, the two agencies with the greatest investment in space activities, had apparently opposed the creation of any new body with responsibility for anything more than an exchange of information. Other interested departments favoured the idea of a consultative group with a policy-planning role and a Cabinet base, but with no budgetary authority. Eventually, ICS assumed this format. In 1969, the Committee's membership included the departments of Energy, Mines and Resources, Transport, Health and Welfare, and Industry, Trade and Commerce, as well as the Science Secretariat, Defence Research Board, Department of Communications, and National Research Council. At first, External Affairs sought only observer status. Within a few months, in keeping with the Ministry's rapidly growing realization that science and technology were important to international policy, External Affairs assumed full membership.

Post-Apollo: Government Response

In order to deal with the post-Apollo question, the Interdepartmental Committee on Space established four subcommittees: scientific research, space vehicles and propulsion, satellite applications, and international aspects. Subcommittee reports would create the basis for policy advice to Cabinet. Over the course of a year's investigation, all concurred, with varying degrees of emphasis, that the United States had made Canada an interesting and attractive offer. Recommendations were otherwise not specific. Visits to NASA laboratories and discussions with American counterparts led the scientists on ICS subcommittees to conclude that many of the shuttle's unsolved technical problems lay within areas of Canadian competence, and could be handled nationally to the further development and benefit of Canadian industry. These experts also felt that an investment in the scientific and technological groundwork of the post-Apollo project would be a sound one because historically Canada had gained significant benefits from such exchanges with the United States. Clearly, some contribution would have to be made just to assure Canada continued access to US scientific and industrial space intelligence as it developed through the progression of the post-Apollo program. A contribution to space shuttle R & D would also guarantee continued access to a US launching platform when conventional ground facilities had been replaced by the new system. From the scientific point of view, therefore, Canada needed only to determine a level of commitment appropriate to Canadian financial and industrial resources.

From an international perspective there were other considerations. In November 1970, during an address to the Canadian Aeronautics and Space Congress and Exposition, then Treasury Board President, C. M. Drury set forth some "exploratory and even hypothetical" notions, the sort of thinking that "is necessary before actual decision-making [can] take place, particularly when large sums of taxpayers' money may be committed by governments to highly expensive programmes."[38] Linking international space acti-

vities with Canadian domestic priorities, Drury referred to the Trudeau government's recent White Paper and its assertion that "to ensure a continuing independent existence, Canada should seek to develop countervailing influences to offset the dominant bilateral relationships with the United States." Continued Canadian cooperation with the United States in space, Drury said, "is undoubtedly desirable and probably inevitable."

> "For this very reason there is a real political need to look beyond the continental relationships. Association with Europe offers such an opportunity and hopefully could be achieved at a tolerable cost."[39]

Canada could "well be in the very fortunate position of being able . . . to adopt several parallel and complementary courses of action at the same time." Participation in the post-Apollo program and continuation of existing arrangements with the United States could be managed in concert with the development of space relations with the Europeans.

Drury suggested that Canada might even seek associate membership in a new European space agency then being formed from an amalgam of Europe's two existing space institutions – ESRO (European Space Research Organization), which was mainly concerned with satellite projects, and ELDO (European Launcher Development Organization), which was trying to develop a launch capability. The new organization would probably evolve "in the direction of a broad-based international space institution," a desirable goal that "would be fostered if Canada . . . should be associated . . . from the outset." The Minister argued further that a Canadian voice "would probably have more influence in the process of evolving an international institution" if raised now among Europeans than if Canada should later and alone "try to influence the United States on the strength of what would necessarily be a relatively very modest contribution to the overall NASA program." Association with the Europeans could also "open the possibility of working with countries more of our size," and perhaps provide Canadians "with an *entrée* to commercial opportunities in Europe to employ the technological capacity which should be developed" through post-Apollo R & D arrangements with the Americans. A space link with Europe would additionally "reinforce efforts now in the active planning stage to foster more intensive scientific and technological relations with Germany, as well as . . . Belgium." In sum, association with Europe "would offer both present and future political benefits as well as the option to participate in interesting and useful practical programs, and would not preclude beneficial arrangements with the United States." The government, Drury concluded, "intends to pursue a space policy consistent with Canadian resources and Canadian objectives."[40]

Some of the scientifically-oriented members of ICS did not regard space activity as an appropriate arena for the pursuit of Canadian foreign policy objectives. While accepting the validity of the White Paper's basic premise that Canada should try to counteract the overwhelming American influence, and agreeing that collaboration with Europe or Japan in various high-technology fields could prove beneficial, these members generally tended to view the space sector as an exception. In 1970, the United States was the only country in the non-Soviet world with a launching capability. American control of the access to space, geographical contiguity, and the productive working relationship that had developed over the years with the United States were all factors militating against any Canadian investment in a European space effort which, to date, had been prominent for its failures and disjointed endeavour. Cana-

da's limited resources should not be diluted by involvement with the quarrelsome members of ESRO and ELDO.[41] A few scientists felt that international space cooperation would be pursued more profitably with Australia, Brazil, or even China and the Soviet Union, countries which shared with Canada a number of common objectives in space applications. Other policy makers contended that collaboration with the European Community, whether on a post-Apollo subsystem or on aeronautical and other satellite programs, would be accompanied by significant political and economic benefits. The current disarray in European space planning, they insisted, was only temporary and obscured a long-term unifying trend. The post-Apollo project and the Canadian-American relationship should not be regarded as the whole of Canada's future space policy.

This argument initially prevented ICS from reaching agreement on an appropriate agenda for cabinet consideration. The matter was further complicated by budgetary considerations. A contribution to space shuttle R & D would have to be viewed in the context of the entire Canadian aerospace program, heavily committed in 1970 to VTOL and especially to STOL development. Canadians had originally hoped for some sort of cost-sharing arrangement with NASA: "in effect a space shuttle production-sharing programme," with a "relatively modest expenditure" of perhaps $2 to 5 million per year.[42] Canada was already spending around $10 million annually on sounding rockets and satellites and there was no provision for a financial undertaking that went too far beyond current space allocations. But NASA policy, firmly established in earlier cooperative ventures, stipulated that there could be "no exchange of funds between nations." Each participating country must accept "financial responsibility for its own contributions."[43] Any exception to the rule would set a ticklish precedent in post-Apollo negotiations with other interested countries. Given the concerns of the American aerospace industry, it would also pose a serious domestic problem. Therefore, Canadians learned that if they wished to make a contribution to the space shuttle program, they would have to pay 100 per cent of their own development costs.

The financing question, together with the internal debate on the merits of collaboration with Europe, underscored the absence of a Canadian space policy, an overall framework within which the post-Apollo proposal might be assessed and understood. The development of a basic policy, on the other hand, was hindered by the urgency of the post-Apollo invitation, by the need to formulate an immediate response. It was a "catch-22" situation made even more difficult by the space committee's weakness in the organizational hierarchy. ICS had "no direct authority or funding ability" and acted as a "forum for the exchange of ideas rather than a forum for decision."[44] From the outset, the interdepartmental committee had appeared as a makeshift measure, an interim device designed to fill a planning gap until the time when some better mechanism could be devised and agreed upon. Within two years the committee's position was further undermined by shifts in the science policy structure. In late 1971 the original reporting channel, the Cabinet Committee on Science Policy and Technology, was disbanded and ICS became responsible to the Minister of State for Science and Technology.

MOSST's "temptation to take on everything," combined with the ICS failure to agree on a future course, led ICS to relinquish effectively its policy role to MOSST. By 1972, MOSST had set up a space task force of its own and ICS

was meeting infrequently, anticipating final demise. Overcommitment of MOSST resources and the antagonisms that developed between MOSST and the established bureaucracies through 1972 and 1973 often hindered policy coordination and slowed the planning process. In the area of space policy formation, MOSST did not produce a working report until the summer of 1973. Finally, after consultation with each ICS department through the fall of that year, guidelines were hammered out and the paper became the basis for recommendations to Cabinet. In April 1974, four and a half years after the quest had begun, the government announced an expanded space policy for Canada. It acknowledged the United States as Canada's chief space partner, and cited Europe as a promising future associate. The policy also endorsed the principle that "a Canadian industrial capability for the design and construction of space systems . . . be maintained and improved."[45]

Post-Apollo: Industrial Response

Canada's space industry was intrigued with and excited by the post-Apollo opportunity and immediately began to examine, in consultation with American planners, the potential for Canadian involvement. Canadian industrial representatives were among the participants at a Washington technical conference on 16 and 17 October 1969, held for the purpose of assessing shuttle concepts and of laying out design considerations for the next steps in shuttle development. By December 1970, Spar Aerospace had prepared a brief for submission to government stressing Canadian experience in the design and manufacture of selected components for the Mercury, Gemini, Apollo, and Skylab programs, and emphasizing the importance of reacting to the NASA offer at an early date so that industry would have a chance to get in on the design stage. NASA had not yet defined a subcontracting policy, but Canadian industry feared that individual firms would have difficulty selling their products or services unless Canada participated on a national basis. Spar predicted that if all the work went to American or European companies, Canadians would lose not only important export opportunities but also a critical technological advantage. The space industry urged the government to respond quickly and positively to the NASA initiative.

While ICS engaged in policy deliberations through 1970 and 1971, Spar began to put together an industrial consortium, and an R & D package that envisaged a major contribution to shuttle development. Feasibility studies were carried out with some funding support from IT&C and in close collaboration with North American Rockwell Corporation, one of the US prime contractors, and officials at NASA's Goddard Space Flight Center. By 1972, Spar had evolved a proposal for the design, development, and construction of a shuttle-attached Remote Manipulator System (RMS). This proposal eventually became the basis for Canadian involvement in the post-Apollo program. The RMS is an arm, 15.2 m long with six degrees of freedom, which will be controlled from the crew compartment of the shuttle orbiter. With electromechanically driven "shoulder," "elbow," and "wrist" joints permitting motion similar to that of its human counterpart, the RMS will be operated by a specialist who will employ it and its end effector or "hand" to manoeuvre heavy payloads in orbit. The RMS will be called upon to deploy and retrieve satellites, and to handle other kinds of expensive and delicate equipment such as the space telescope and the space tug. The remote mani-

pulator will be essential to the shuttle's task, and is therefore regarded as a "mission critical" system.

The RMS project also came to be regarded as "one of the most important developments for the future of space research in Canada,"[46] but through 1972 and most of 1973 the question of federal support was much in doubt. In the absence of a national space policy, and in face of a completely decentralized government space organization, the proposal appeared to flounder. A high government-to-industry cost-sharing ratio meant that IT&C could not fund anything more than the most preliminary studies without dramatically shifting its industrial assistance budget toward the more speculative end of the risk spectrum. Although the Department of Communications was the one federal agency that "clearly embraced space,"[47] DOC could not support the proposal either, because RMS technology appeared to have only an indirect bearing on the departmental mandate. Eventually, NRC undertook to study the plan, but by mid-1973 the consortium's frustration was evident. In a report submitted to the government that year, the Air Industries Association (AIAC) criticized the impotency of the Interdepartmental Committee on Space, and lamented the uncoordinated diffusion of space interests among a dozen departments and agencies. "Individual departments have difficulty in justifying space expenditures per se," the AIAC suggested, because they are "not concerned with space." They only use it as "a means to the end of satisfying their particular departmental mission." The lack of direct commitment and the fragmentation of federal space interests create "a most difficult problem for the domestic industry serving those interests." The aerospace association recommended, therefore, the establishment of a government-industry infrastructure and the development of a "strategic plan" that would make better use of existing funds, improve the organization of space activities, and foster government-to-industry communication.[48]

Space organization in Canada remains decentralized, and an effective government-to-industry mechanism has yet to evolve, but the cogency of the AIAC argument may have had some impact on the government's decision to support the RMS proposal. The government may also have been influenced by the example of the Europeans, who concluded a post-Apollo agreement with the Americans in September 1973. A NASA/ESRO Memorandum of Understanding called for the European design, development, manufacture, and delivery of a half-billion-dollar spacelab unit – a scientific laboratory to be carried on board the shuttle orbiter. A highly favourable NRC evaluation of the RMS project, however, was probably the material factor. Around the time of the AIAC submission, NRC experts were reaching the conclusion that the program would be a valuable one. Not only would it help to maintain and improve Canada's industrial capability in the design and construction of space systems, it would create a unique technological base in the highly advanced field of teleoperators and robotic machinery. Similarly, the MOSST task force, in its search for an overall space policy, was moving toward the general conclusion that Canada should develop further and build on existing areas of space expertise. Through the latter part of 1973, a consensus had begun to emerge. Policy makers were gradually overcoming their worry that the RMS proposal might prove to be another instance of an unhappy Canadian tendency (going back at least as far as the Arrow) to earn minimal returns from major investments in high technology. Instead, space industry requirements were rationalized in the context of the government's growing concern over Canada's

capacity for innovation, and with the pressing need to develop appropriate technological strategies.

In 1972, Cabinet had established the "Make-or-Buy" program, a policy designed and implemented by MOSST to increase the proportion of government R & D contracted to industry rather than performed in the government's own laboratories. Its goal was to strengthen the innovation process and enhance the competitive position of Canadian industry. In February 1974, on MOSST's initiative, Cabinet extended Make-or-Buy "to provide for consideration and financing of Unsolicited Proposals for Research and Development from the private sector."[49] This modification, together with Cabinet's April 1974 approval of an expanded space role for Canada, provided the policy basis for government support of the RMS proposal. In July 1974, the Minister of State for Science and Technology announced that the National Research Council had "begun discussions . . . to explore possible Canadian participation in the United States space shuttle program," and that Treasury Board has approved the allocation of $1 million to fund studies of the project.[50]

One year later, NRC and NASA signed a Memorandum of Understanding to provide for the implementation of a joint program in which NRC undertook "to assure the design, development, manufacture and delivery by a Canadian industrial team of the first flight unit of an RMS . . . ." The Memorandum further set out "the provisions for access by Canada to the use of the Space Shuttle and for procurement by NASA of additional RMS units," and established the "cooperative structure . . . for dealing with all questions concerning interface between the Shuttle and RMS programs."[51] Under the Make-or-Buy program, monies were granted by Treasury Board for an initial estimated cost of $75 787 000. An additional $12 million was provided as a contingency fund to cover design uncertainties, bringing the final estimated cost to $89 930 000. The size of this expenditure, together with the important policy implications, dictated the need for a treaty commitment. By means of a June 1976 Exchange of Letters, the government of Canada and the government of the United States raised the status of the NRC/NASA understanding to that of an intergovernmental agreement.

Implementation and Results

Spar Aerospace Products Limited, the initiator of the RMS proposal, serves as a prime contractor on the industrial team responsible for carrying out the agreement. Spar is performing overall systems engineering and integration as well as arm fabrication and assembly. Dilworth, Secord, Meagher and Associates of Toronto, who worked with Spar on the initial plans, are acting as engineering consultants. They are designing and building special testing equipment, and working on various concepts for the end effector or manipulator "hand." CAE Electronics Limited of Montreal is handling the control and display subsystem and contributing to software development. Spar Technology Limited[52] has responsibility for the electronic subsystem, including an on-board computer and its interfaces, video system, sensor electronics, servo amplifiers, and power conditioners. Another 25 Canadian companies, in addition to these major subcontractors, are providing component parts and services.

Since the RMS cannot be tested properly in a gravity environment, the industrial team has also developed SIMFAC, the general purpose manipulator system simulation facility, located at a Spar plant in Weston, Ontario. SIMFAC

will employ mathematical modelling techniques for 60 per cent of RMS testing, with the remainder of the verification to be carried out in two dimensions under simulated zero-gravity conditions. Phase B, the preliminary design stage which included construction of SIMFAC, was successfully completed on schedule in October 1976. Phase C, the critical design phase, successfully wound up with a NASA review in April 1978. Since 1 January 1978, the RMS program has been in Phase D, the stage encompassing manufacture of the qualification and flight test units. The first manipulator arm is scheduled for delivery to NASA in July 1979. It will be flown on a space shuttle orbiter test mission in September.

Canada's participation in the development of the American space transportation system assures Canadians preferred access to the shuttle for satellite launching or refurbishing missions, as well as for scientific experiments. Launch services will be made available to Canada on the same basis as to US civilian government agencies, thus reducing overall cost by eliminating the payment of a $3 million "user charge."[53] Telesat has already informed NASA that Canada will require use of the shuttle for the orbiting of Anik C-1 and Anik C-2, high-frequency communication satellites scheduled for launch in 1980. Involvement in shuttle development will also facilitate acceptance of Canadian proposals for scientific research. Spacelab, the orbiting laboratory being constructed as the European contribution to the shuttle program, offers the potential for a wide range of scientific and technological investigations, including materials science – the practical industrial applications of the weightless, vacuum environment of space. Full use of Spacelab is dependent, of course, on the resources available to Canadian space scientists. So far, one Canadian proposal has been submitted and accepted by NASA. On the first shuttle mission, an experiment in space sickness and space disorientation will be conducted by the Defence and Civil Institute of Environmental Medicine.

According to one recent NRC estimate, the 29 Canadian companies involved in RMS development are directly employing 650 people on the project, and 4000 jobs are being created indirectly. The project is strengthening Canadian capabilities in the design and manufacture of space systems by providing program management experience in all facets of a space R & D program including integration and testing – the first such opportunity offered the industry to date. Besides establishing prime contractor competence in Spar Aerospace, RMS development has also increased, through subcontracting, the number of Canadian firms with experience in space work. The program has further stimulated the major contractors to enlarge existing levels of skill and expertise in a number of technological fields with both space and non-space applications, including systems analysis, human factors engineering, microprocessors, advanced mathematical formulations, and simulation of electromechanical systems. International Hydrodynamics Limited of Vancouver, "a struggling company which last year had a loss of $5 million and laid off 75 of its 125 employees" recently secured a $1.5-million contract from NASA for a device that will retrieve the rocket boosters from the shuttle for reuse after they have been dropped into the ocean.[54] Another firm, Barringer Research Limited of Toronto, has a $1-million contract to design space pollutant sensing equipment. The single-source nature of Canada's space industry and its heavy dependence on government contracts have made it susceptible in the past to the draining effects of random, uncoordinated loading. It is

now hoped that by suitable choice and phasing, a non-fluctuating workload can be achieved, lending the industry new vigour and stability.

Under the revised terms of the space shuttle agreement,[55] NASA will be contracting to buy from Canada, at a cost of about $55 million, four one-arm RMS units for the four shuttle orbiters NASA currently expects to build. This return, by itself, does not amortize the taxpayers' investment, but additional sales of related hardware, such as end effectors and grapple fixtures, are also expected. In any case, the attainment of full value lies in the prospect that Canada will achieve "world pre-eminence in the most advanced tele-operator technology . . . with potential for applications in other environments, and a high visibility for its products."[56] The RMS project is providing the space industry with the technological substructure for making Canada a unique supplier of remote manipulator systems for all environments hostile to man. Further applications could include nuclear reactor plants, and the environments of deep water and the high Arctic. Under a contract with Atomic Energy of Canada Limited, Spar is presently investigating the possibility of applying RMS technology to fuel recycling. In a cooperative program with Germany, being carried out under the aegis of the general science and technology umbrella, Spar is examining the feasibility of an Advanced Remotely Controlled Undersea System to carry out unmanned torch cutting and welding on ocean pipelines. Spar is also studying various space applications of RMS technology through contracts with the University of Iowa, Singer-Link Corporation, and Toronto's Defence and Civil Institute of Environmental Medicine.

If future projects of space stations and other possibilities such as space power generators ever materialize, Canada will have the technological base necessary for the construction of these large space structures.[57] On a more immediate and practical level, Canadians expect to translate RMS technology to specific applications in all environments. A medical application currently being examined under contracts with the Ontario Crippled Children's Centre and the University of Virginia is a wheelchair manipulator for quadraplegics. Canada does have the lead in many aspects of RMS technology. Sustaining that lead will require an additional government commitment. Funding for continuing research and applications engineering will be necessary until the space industries are able to pick up the costs of their own study contracts, and underwrite their own R & D.

Significance

Although the remote manipulator system will not undergo operational, non-simulated flight testing until late 1979, the probability of success seems high. The program is on schedule and proceeding well. As an example of a Type III international science and technology agreement, the RMS project demonstrates the obvious advantages of area- or project-specific cooperation. Objectives can be clearly set out and directly related to specific requirements of scientific or technological growth, export development, or any other priority. The smooth functioning of the shuttle agreement is also attributable, of course, to the special characteristics of the Canada-United States relationship. The long history of Canadian-American cooperation in space and the existence of close industry as well as government ties facilitated the collaborative process. The mechanisms for implementation of the agreements were already well-established.

An investigation of a Type III agreement with a culturally dissimilar country – the atomic energy agreement with Italy, or the oceanographic agreement with Japan or, to look at the same sector, one of the space agreements with Europe – might have provided a more equitable counterpoise to the Type I case study on Belgium. Nevertheless, there is an offsetting advantage to the space shuttle study. It clearly illustrates the benefits that have been derived from Canada's science and technology relationship with the United States over the last 20 years in at least one area of vital economic and social significance. It also illustrates the sort of policy conflict and organizational confusion that can inhibit the evolution of national industrial strategy and discourage technological growth. Participation in the space shuttle program appears to fulfill all the requirements for development in a sector of key importance to Canada. Yet it took the government four years to come up with a decision, and without the space industry's initiative the program might never have been undertaken. Canada might well have acted on the post-Apollo invitation in the same manner as the Australians or the Japanese. Australia decided in 1972 that, in light of existing resources, the country could make no technical contribution to shuttle development. Japan, despite an initial expressed interest, eventually studied the question only from the standpoint of "possible payload input."[58]

Decentralization was the major problem in the formation of a Canadian policy response to post-Apollo, not only in terms of weak government-industry links but also in terms of intragovernmental coherence. The strengthening of the Interdepartmental Committee on Space has contributed to a more rational effort over the last three years, but space policy planning still suffers from fragmentation. Since 1975, ICS has been reporting to the Department of Communications rather than MOSST and in 1976 a permanent secretariat was established. But ICS still has no budgetary authority. The Committee's mandate assigns it a primarily advisory role. Through three subcommittees – on the international, industrial, and scientific aspects of space policy – and by consultation, the members who represent nine departments mainly consider, review, and assess. ICS does not even have responsibility for all liaison and coordinating functions.[59]

Although Canadians now spend five times as much on space as they did in 1970, the organization of space activity in Canada remains completely decentralized. The $50-million a year program has expanded not only in terms of cost, but in range, complexity, and significance. Since 1974 alone, Canada has negotiated a dozen international space agreements in areas as diverse as ionospheric research, remote sensing, shuttle technology, aeronautical satellites, and data processing and transmission. For the last three years, Canada has had observer status with the European Space Agency (finally formed from the merger of ESRO with ELDO in 1975), and is currently considering the implications of membership. Canadians also engage in various kinds of informal cooperative activity and must continuously monitor an increasing number of globally important space interactions. The scope of the bilateral and multilateral commitment, together with enhanced domestic responsibilities and the development of expensive new capabilities in the construction of space systems, suggest that Canada's task may have outgrown the interdepartmental committee structure. Policymakers should perhaps reconsider the idea, set forth by the Science Council over a decade ago, of a "central coordinating and contracting agency for space research and development."[60] Such an

agency would have the budgetary authority, central management capacity, and organizational base needed to encourage the growth of technological skills and expertise in the industrial sector, while attending to the space program requirements of the government's research, development, and user communities.

Type IV

The Type IV category of international science and technology agreements encompasses the five exchange arrangements signed by NRC with counterpart agencies in the Soviet Union (1959), Brazil (1968), Czechoslovakia (1969), France (1971), and Japan (1975). It also includes an earlier French exchange agreement, signed with the Quai d'Orsay in 1969 as a follow-up to the Type II umbrella, and a 1965 Protocol with Yugoslavia. The former agreement has gradually been phased out in favour of a 1971 arrangement with the *Centre national de la recherche scientifique.* The Yugoslav agreement, concluded in Belgrade with the Yugoslav Federal Council for the Coordination of Scientific Activities, formally linked the two organizations in a post-doctoral program. The exchange was never implemented because NRC turned down a request that the Yugoslavs be permitted to designate the candidates for Canadian tenure. Although the agreement has no terminal date, it is no longer considered valid.

At first glance, the Type IV classification would appear to offer strong potential for scientific success. An agreement between two science-based agencies suggests, in contrast to the politically conceived Type I or II umbrella, that scientific demands were the key motivating factors and that scientists acted as the chief negotiators. The responsibility for implementation is not dispersed among a host of participating departments, but is carried out instead by the two agencies that have signed the agreement. A closer look reveals, however, that while a Type IV arrangement is an administratively less burdensome and less expensive form of cooperation than an umbrella, motivations tend to be similar. Diplomatic interests have generally been served more often than scientific interests. Political advantages seem to outweigh any other and, in most cases, the scientific gains have not been substantial.

The National Research Council concluded its first international agreement with the Soviet Academy of Sciences, and it is this 1959 accord that is generally regarded as the most successful. Under an Exchange of Letters, signed by the NRC and Soviet Academy presidents, a small cooperative program was inaugurated. Between 1960 and 1972, in visits of varying duration, 86 Soviet scientists visited Canadian laboratories and 100 Canadian researchers went to the Soviet Union. Despite some difficulties in administration, the absence of full reciprocity, and the program's minimal size, the arrangement has generally worked well and is regarded as a beneficial one. Institutional links as well as individual contacts between government and university scientists and their counterparts in the USSR have been established, and the agreement has had the important function of obtaining up-to-date and fairly reliable assessments of the state of Soviet science. Certainly it helped smooth the way for other kinds of interagency scientific exchanges, such as the Type III arrangements that developed in the mid-1960s between government departments and Soviet state committees. It also helped provide a basis for the subsequent expansion of science and technology relations under Type I and II umbrella agreements. In 1972, the National Research Council and the Soviet Academy of Sciences replaced the 1959 Exchange of Letters with a new Agreement on Scientific

Cooperation which continued the exchange of scientists program, agreed on the desirability of joint research projects, and provided for the holding of jointly sponsored scientific symposia.

Travel and currency restrictions in the Soviet bloc frequently prevented Russians and East Europeans from participating in the normal flows of international science. Formal exchange agreements offered scientists the chance to get abroad, to attend international conferences and symposia, and to open and maintain links with counterparts in the West. The willingness of the Soviet political leadership to cooperate in scientific exchange with Canada and other Western nations was rooted in a desire to secure access to Western scientific and technical expertise. The subsequently inoperative Yugoslav Protocol and the agreement with the Czechoslovak Academy of Sciences indicates that East European leaders shared the Russian concern.

Czechoslovakia was one of the Bloc countries most anxious to develop scientific relations with Canada. During the Dŭbcek liberalization period, when Czechoslovakia fielded its highly successful exhibit at Expo '67 in Montreal, the Czechoslovak Academy began the negotiation of an exchange agreement with NRC. Canadian scientists may have regarded the conclusion of the June 1969 accord less as a way to gain scientific benefits than as a gesture of solidarity with beleaguered colleagues. Czechoslovakia had just endured the Warsaw Pact invasion, and the NRC association was one of the few positive forms of Canadian-Czechoslovak relations to survive the events of 1968. The program is the smallest of the Council's formal exchange arrangements. Through 1970 and 1971, for example, only eight Canadians went to Czechoslovakia and all were on short visits of 7 to 28 days duration. Over the same term, seven Czechoslovak scientists worked in Canada for periods ranging from six months to a year, with a fifth researcher visiting for 30 days, in the fields of virology, chemistry, mechanical engineering, geophysics, and astronomy. One joint project involved the stratospheric testing of measuring instruments, launched in 1970 from Churchill Research range aboard Canadian Black Brant rockets. Although the scientific advantages of cooperation with Czechoslovakia have not been great, NRC was persuaded to renew the agreement in 1973. Continuation of the exchange program seemed a relatively inexpensive way of promoting detente, and of ensuring some meaningful form of contact with a country that has sought closer relations with the West.

The agreement with Czechoslovakia, like the agreement with the Soviet Union, was signed by the president of the National Research Council and his counterpart at the Academy of Sciences. The 1968 arrangement with Brazil, in contrast, is an intergovernmental agreement, published in the Canada Treaty Series, which names NRC as the implementing agency. The 1969 accord with France evolved in yet another fashion. It was established according to the minutes of a Franco-Canadian Joint Commission meeting, held under the provisions of the 1965 umbrella. In the case of Brazil, the difference in procedure arose partly from the requirements of political organization in that country. In the case of both Brazil and France, the difference also reflected the growing impact of foreign policy goals on international scientific relations, and the accompanying changes in the decision-making structure. In considering a French accord, NRC would have liked to negotiate a direct exchange with its counterpart, *Centre national de la recherche scientifique,* but other policy considerations prevailed and the exchanges were included instead under the cultural umbrella. Hence NRC became involved in a cooperative sci-

entific program with the Quai d'Orsay which was never very satisfactory, and which was eventually replaced by a second agreement of the kind originally envisioned.

NRC scientists naturally assessed Type IV arrangements in terms of their scientific value to Canada. While acknowledging a political dimension to all the agreements, they generally resisted the idea of renewing those in which benefits were primarily political. Those policymakers responsible for the development of Canada's external relations felt, on the other hand, that all government agencies should be responsive to the government's broader objectives, and that NRC agreements could be justified by factors other than those dictated by NRC policy. The conflict between these two points of view was sharpened by the imposition of the government's restraint program. When the 1968 exchange agreement between NRC and the Conselho Nacional de Pesquisas (CNPq) in Brazil came up for renewal, NRC argued like other science-based departments caught in similar funding dilemmas, that the agency could no longer afford to support the program. Between 1969 and 1973, about 40 Canadian biologists, engineers, computer scientists, chemists, and physicists had gone to Brazil, mostly on short-term visits of six weeks to a month or less. Over the same period, some 23 Brazilian scientists had come to Canada for both short and long-term visits.[61] In 1971 the CNPq indicated Brazilian enthusiasm for the agreement by doubling its share of the program budget, but NRC officials tended to regard the accord as being more within the purview of development assistance than of scientific cooperation. Thus when the exchange was renewed in 1973 for a further five years, NRC retained its coordinating role but CIDA (Canadian International Development Agency) assumed the funding. A similar compromise was reached with regard to France, when External Affairs agreed to support NRC exchanges taking place under the cultural umbrella.

The National Research Council's most recent agreement was signed in May 1975 by the NRC president and his counterpart at the Japan Society for the Promotion of Science (JSPS). It provides for an exchange of scientists, and for collaborative research projects and scientific seminars in various fields of exact, natural, and applied sciences. Unlike the Russian and Czechoslovakian cases, an agreement was not required as a facilitative mechanism to ease the problems of travel restriction and currency exchange. Relations between Canadian and Japanese scientists, moreover, were already fairly well established on an individual basis. But the NRC/JSPS understanding fitted in with the Trudeau government's goal of broadening relations with Japan, and many members of the scientific community had long felt that Canada could benefit from more structured access to Japanese science and technology. The agreement has only been in force since April 1976, so it is too soon to judge its effectiveness. Early indications are, however, that while Japanese scientists are putting the accord to good use, Canadian scientists are having some difficulty achieving reciprocity.

Generally speaking, Type IV arrangements have not made any significant contribution to the growth of Canadian science or to the development of Canada's research capabilities. On the other hand, there is little doubt that some individual scientists have benefitted, and continue to do so. This has been particularly true in the case of the Soviet exchanges, but also applies to a lesser extent with regard to the French, Czechoslovak, and Japanese agreements. There are administrative difficulties, especially in the operation of the

Soviet and Czechoslovak programs, but compared with an umbrella framework these are minimal. Similarly, costs appear to have been kept within acceptable limits. NRC's international agreements do not appear to have generated large scientific advantages, but in strengthening relations with countries of diverse importance to Canadians, they have had a useful political impact quite appropriate to the level of investment.

IV. Inventory of Cooperation

The Developing World

Background

Canada began its science and technology relationship with the developing nations in 1945 under the aegis of the United Nations. Through specialized UN agencies like the Food and Agriculture Organization (FAO) and the Educational, Scientific and Cultural Organization (UNESCO), the Canadian government embarked on a number of scientific and technical assistance projects. Under the Canada-UNESCO fellowship program, government officials or senior civil servants from countries as diverse as Iraq, Haiti, Malta, Cambodia, and Mexico came to Canada to study hydroelectric power and industrial development, and to learn the techniques involved in geological surveying, veterinary services, agriculture, forestry, communications, and many other fields. In the early 1950s, the emphasis shifted from receiving trainees in Canada to sending experts abroad in both a training and advisory capacity. Under the Colombo Plan for the Asian countries of the Commonwealth, training and advising was combined with capital financing to start fisheries production in Ceylon, build a cement plant in Pakistan, and construct irrigation facilities in India. Other developing Commonwealth countries also became areas for priority attention as the Canadian government expanded its efforts through a second decade. With equipment, and through the transfer of technical knowledge and expertise, Canada aided such Caribbean nations as Antigua, Barbados, British Honduras, Dominica, Guyana, Jamaica, Monserrat, St. Lucia, Trinidad and Tobago, and African nations like Botswana, Gambia, Ghana, Kenya, Nigeria, Tanzania, Uganda, and Zambia.

In the latter part of the 1960s, the francophone nations of Africa were added to the list of countries for whom Canada felt a "special sense of concern and responsibility."[1] Aid, in the form of science and technology, was frequently extended to these countries by means of formal agreements. For instance, Canada signed a technical and cultural accord with Tunisia in 1964, and set up an umbrella-style Mixed Commission as its implementing mechanism in 1968. The 1971 Agreement on Economic and Technical Cooperation with the Federal Republic of the Cameroon, on the other hand, more simply provided for cooperation to be established "on the basis of programmes and projects" approved by both governments.[2] A formal mechanism for multilateral cooperation amongst Canada, eight other French-speaking nations, and 14 countries in francophone Africa was created in 1970, with the founding of the Agency for Cultural and Technical Cooperation. The attention directed towards *la francophonie* was, and remains, one reflection of a domestic political goal – the government's desire "to reaffirm Canada's bicultural character."[3]

Historically, scientific and technical assistance programs, like other forms of Canadian development aid, have been motivated by a melding of philanthropy with various domestic and international political and economic objectives. Implementing these objectives often involves the private sector, through contracts to consulting firms and industries or universities and other private organizations. It also requires the participation of the science-based departments of the federal government, working through UN agencies and other multilateral forums or in bilateral arrangements funded by CIDA. The aid-directed activities of the technical departments form a not insignificant proportion of the Canadian government's overall participation in international

science and technology. Except for atomic energy agreements with developing countries (listed in Appendix A), a catalogue of the numerous bilateral technical-assistance agreements and an accounting of the multifaceted work carried out through the various development-oriented international organizations lie outside the scope of this study. However, one group of developing nations merits consideration here. The economic characteristics and expanding political significance of certain resource-rich, semi-industrialized developing countries place them in a different category. Science and technology relations with these countries offer some of the same potential benefits, and create similar policy problems, as do science and technology relations with many nations in the developed world.

The More Advanced Developing Countries (MDCs)

The MDCs are the more advanced developing countries like Brazil, China, South Korea, Mexico, Iran, Venezuela, and most of the other OPEC nations, whose economic development over the last decade and/or burgeoning industrial capacity set them apart from the LDCs – the less developed countries. With their increased economic power, the MDCs have gained proportionately in international political strength and they are important voices in the Third World majority. They are also commercially important to the developed nations, for their expanding needs have created valuable new markets. In its 1970 White Paper, *Foreign Policy for Canadians,* the government pointed out the advantages of buttressing ties with those countries that occupy a position "midway between those of the advanced nations and those whose resources have scarcely begun to be explored . . . . The general drive toward a more industrialized society and toward economic development . . . opens the way to the sale of Canadian capital equipment and technical services."[4] The White Paper specified telecommunications, grain-handling equipment, hydoelectric and nuclear power, pulp and paper machinery, specialized aircraft, and subway, road, and rail technology as examples of areas where Canadian industries were particularly well-qualified to construct necessary facilities and provide technical expertise. Strengthening ties with some MDCs, moreover, may offer both enhanced export opportunities and security of access to scarce resources. For instance, Canada has recently expanded relations with Venezuela, by means of air and trade agreements and a prime ministerial visit, to help promote the sale of Canadian equipment for transportation and other major public works projects, as well as to help ensure the continuing supply to Canada of Venezuelan petroleum and petroleum products.

In choosing appropriate mechanisms for the further development of bilateral relations with the MDCs, Canadian policy makers have had to consider increased cooperation in science and technology. The MDCs are eager to expand their rate of economic growth through improved access to the know-how of the developed world, and they generally view that access as a fair exchange for new trade and investment opportunities. At the same time, some MDCs are seeking ways to limit their technological dependence on the United States, and are looking for other sources of expertise. Countries like Venezuela and Mexico, for example, who possess "a new sense of international importance," and a feeling that they are "being ignored or taken too much for granted by the United States," view Canada as a welcome alternative.[5] Thus a number of the more advanced countries in the developing world have requested science and technology cooperation from Canada in specific fields or

on specific projects, and the expansion of science and technology relations under an umbrella framework or within the context of a general economic accord.

Formulating a coherent response to initiatives from the MDCs has sometimes been complicated by a lack of policy coordination. The example of Mexico is illustrative. During President Echeverrìa's visit to Ottawa in the spring of 1973, the Mexican and Canadian governments agreed, in a Memorandum of Understanding, to an "Exchange Program of Young Specialists and Technicians."[6] In a joint communiqué issued by Echeverrìa and Prime Minister Trudeau, Mexico and Canada also agreed to promote exchanges in the environmental field. A follow-up mission to Mexico headed by a senior official from Environment Canada determined that there would be little scientific benefit for Canada in cooperative environmental undertakings with Mexico. Government departments in other spheres of activity tended to view science and technology relations with Mexico in a similar light. In addition, finite resources and administrative experience in implementing existing agreements had already led most officials to conclude that Canada should not make any more formal commitments, particularly to countries with limited scientific and technological capabilities. Yet at the January 1974 Canada-Mexico Ministerial Committee Meeting, cabinet ministers from both countries "agreed that the search for areas of fruitful exchange should be continued and intensified," and "further agreed that final consultations should start immediately towards the conclusion of a cultural and science and technology agreement between the two governments."[7]

This confusion among policy makers in the Mexican case appears to have been a result of differing perceptions of the value to Canada of science and technology agreements. One page of the ministerial communiqué was entirely given over to trade and investment developments, including the possibilities for interfirm cooperation and joint ventures in a number of high-technology industrial fields. The Canadian ministers, according to the communiqué, were additionally "pleased to note the interest of the Mexican Government in nuclear plants." Those Canadians who prepared for, and participated in, the ministerial meeting with Mexico seem to have viewed the conclusion of a formalized cultural and science and technology agreement as a necessary spur to the development of commercial relations. Hence they were probably more concerned with the enhancement of Canadian economic opportunities than they were aware of the operational effects of an umbrella, in terms of its cost and the often unwelcome obligations imposed on the line departments. Similar policy confusion may exist not only within the bureaucracy but between the bureaucracy and the legislative branch of government. A communiqué issued at the close of the Canada-Mexico Interparliamentary Meeting in March 1977 stressed the importance of increased science and technology contact for the general improvement of Canadian-Mexican relations, and called for stepped-up efforts. The legislators of both countries also agreed that "it would be of great use to negotiate through appropriate channels an agreement of scientific and technical cooperation . . . ."[8] To date, and in spite of these public espousals, Canada has not signed a formal agreement with Mexico. The Young Technicians Exchange Program remains the only substantive area of bilateral cooperation in science and technology.

In the case of South Korea, the possibility of a general science and technology agreement apparently arose in 1973 and 1974, in the course of

discussions on Korean acquisition of a CANDU reactor. Some officials, concerned this time with the promotion of Canadian commercial interests in Asia, seemed to feel that a formal agreement might alert the Koreans to the measure of Canada's technological expertise in sectors other than atomic energy. These policy makers ascribed AECL's successful bid to the experience of Korean nuclear scientists who had come to Canada under NRC post-doctoral fellowships and the NRC-CIDA Research Associates Program. (Indeed, the South Korean Minister for Science and Technology had once studied nuclear science in Canada under International Atomic Energy Agency sponsorship.) But other officials presumably insisted that the resources of the mission-oriented departments were fully engaged in exchanges with nations meriting a higher priority than South Korea, and that formal agreements did not, in any case, necessarily ensure benefits. The South Koreans were encouraged, instead, to bring to the attention of the Canadian government specific proposals for cooperation so that these might be judged on their scientific worth and acted upon accordingly.

A request from an MDC for cooperation on an informal basis, nevertheless, may also pose difficulties for policy makers. Before 1975, the science-based departments and agencies of the federal government were able to extend their technical expertise to the MDCs in particular fields or on special projects wherever CIDA was willing to pick up the costs. Changes in CIDA policy since 1975 have now made the MDCs ineligible for such funding. The new CIDA strategy is to focus on the poorest nations, rather than on those past recipients "who have succeeded in graduating from Third World slums."[9] Instead of concentrating on industrial and infrastructural development in MDCs by means of capital-intensive projects in fields like atomic energy, communications, and transportation, CIDA is centering most of its attention on rural development in LDCs through agricultural, health, and educational programs. This shift in CIDA priorities means that the Canadian government is sometimes unable to react in a positive manner to various useful proposals made by the MDCs for informal cooperation. IT&C could comply with a bid for technical assistance if some commercial advantage is immediately made clear. Similarly, a science-based department might respond by fitting a trainee into an existing domestic program, or by providing expertise for a project of interest to the department. But impromptu responses such as these can generally satisfy only a fraction of the demand, and do not answer the need for a coordinated policy directed toward the long-term objective of strengthening relations with the OPEC countries and other advanced nations of the developing world.

Brazil

The political and economic significance to Canada of strengthened relations with the MDCs, and the role of science and technology in the augmentative process, has recently been emphasized by the expansion of ties with Brazil. In January 1977, Canada signed a package of economic accords that generally favoured enhanced cooperation in science and technology, and that specifically provided for joint ventures in different areas of industrial technology. The formal link with Brazil goes back to a 1944 Type II cultural agreement, which includes the statement that the two countries should encourage and facilitate the exchange of scientific and technical publications. Only in 1968, however, with the conclusion of an Exchange Agreement between the National

Research Council and the Conselho Nacional de Pesquisas, did Canada and Brazil become involved in a joint scientific program.

According to NRC, the objectives of the Type IV arrangement with the CNPq were "to strengthen and intensify relations in a coherent and coordinated manner, taking into account the dynamic growth and the potential in Brazil and the opportunities offered by the pace of its development and influence."[10] By doubling the budget after 1971 for their share of the implementation costs, the Brazilians clearly demonstrated their continuing interest in the agreement. As noted in Chaper III, however, the scientific benefits for Canada have not been substantial and NRC did not follow suit. When the agreement was renewed in 1973, NRC retained its administrative role but CIDA took over the financing for the following five-year term. The question of funding will have to be examined again when the agreement comes up for a second renewal, since Brazil may no longer be eligible for CIDA assistance.

If Canada and Brazil can develop science and technology programs under the 1977 economic understandings, a rationale might be created for terminating the NRC-CNPq arrangement. The new accord offers the Brazilians financial assistance and Canadian technological expertise in exchange for major industrial commercial opportunities. It emphasizes private-sector involvement, including a joint venture in the development of metallurgical coal, and Canadian participation in Brazilian projects in the electrical, oil, pulp and paper, potash, and bauxite industries. According to the communiqué issued during the January 1977 visit of External Affairs Minister Donald Jamieson to Brazil, conversations held in September 1976 by Canada's Agriculture Minister with his Brazilian counterpart "identified good possibilities for increasing technical cooperation and carrying out joint ventures in forestry, fishing and agriculture."[11] Sharing in Brazil's 1977-1981 Second National Program of Technical Cooperation, Canada pledged $17.5 million, and Brazil, $62.7, to bilateral endeavours in the latter fields, as well as in the geological, electrical, telecommunications, urban development, and food and computer science sectors. On Canadian initiative, a Memorandum of Understanding was also signed that provided for Brazilian-Canadian coordination of "efforts and resources in technical cooperation with the developing countries . . . in fields such as food production and marketing, housing and technical training." Finally, Jamieson and the Brazilian External Affairs Minister "concurred in the desirability of increasing cooperation in the general field of science and technology. For this purpose it was agreed that the best way to identify the possibilities would be by an exchange of study teams composed of appropriate scientists."[12]

The provisions for technical cooperation, which are tied to export promotion and the understanding of joint technical assistance to Third World countries that are eligible for CIDA aid, should pose no funding difficulties. However, the encouragement of new cooperative activities "in the general field of science and technology," and the proposal for an "exchange of study teams," again raises the question of who is to pay. The science-based departments, who would normally implement these suggestions, are not obligated to use their expertise in development assistance or in furthering foreign policy goals when the exchanges have no value for domestic programs and must be carried out at departmental expense. On the other hand, Brazil and the MDCs generally assign a high priority to science and technology exchanges with the nations of the developed world. Given Canadian perceptions of their

expanding economic potential and increasing global political significance, a rational response seems necessary. In addition to bilateral interests, international obligations must also be considered. In multilateral forums, Canada has publicly endorsed the application of technology to Third World needs, and the transfer of appropriate technologies to both the LDCs and the MDCs. At the 1979 United Nations Conference on Science and Technology for Development (UNCSTD), Canada will be asked to discuss the bearing of national policies and plans on international development goals. In the case of the LDCs, the activities of the International Development Research Centre (IDRC) and of CIDA may suggest a constructive and sometimes innovative Canadian contribution, but in the case of the MDCs, an absence of policy may be apparent. However, the recent expansion of scientific and technological cooperation with Brazil, as well as the approach of the UNCSTD meeting, have underlined the problem. The government currently has the whole question of Canada's present and future science and technology relationship with the MDCs under interdepartmental review.

The Special Case of China

The high degree of priority that the Canadian government has attached to the development of relations with the People's Republic of China, and Chinese advances in medicine and certain economic sectors not paralleled by other MDCs, place the evolution of Sino-Canadian science and technology cooperation in a somewhat special category. In the late 1950s and early 1960s, as China opened the door to trade and Canadian wheat imports, some informal scientific links were also established. The National Research Council undertook an exchange of publications program with the Chinese Academy of Sciences, a few Canadian scientists visited the People's Republic of China on an individual basis, and in 1964, McGill University inaugurated the Bethune Medical Exchange Program. These contacts were discontinued in 1966, with the advent of the Great Cultural Revolution. Only in 1970, with negotiations leading to Canada's accordance of diplomatic recognition to China, did the Chinese begin to express an interest in resuming scientific communication.

Through 1970 and 1971, the People's Republic of China also broached an interest in Canadian industrial technology. With the development of Sino-Soviet hostility and the end of the Cultural Revolution, the Chinese had begun to focus increasingly on Western scientific and technological capabilities. Over the last dozen years, China has concentrated resources in a number of high-technology sectors and produced remarkable results. The Chinese have developed nuclear weaponry and rockets, orbited a number of satellites, advanced research in insulin synthesis, and achieved an impressive level of sophistication in polymer chemistry and in the machine tool and electronics industries. Nevertheless, China is still a developing country and expertise in most fields remains limited. China's current vice-premier, who also heads the government's Science and Technology Commission, recently warned his countrymen that they lag "15 to 20 years behind world standards in many areas."[13] The Chinese have included energy resources, lasers, high-energy physics, and genetic engineering as priority sectors in their latest scientific development plan. They have also a special, long-standing concern with securing modernizing technology for agriculture and rural industry, the traditional sector in which the great majority of the population is employed. Thus, as one observer noted, most science and technology exchanges between China

and the industrialized West have been initiated by China. "Chinese scientific, technical and engineering missions have gone abroad to dozens of countries, even to neighbouring Hong Kong, to study everything from oil exploration and pipelines to the construction of modern hotels."[14] Foreign trade and technical exhibitions in China have additionally provided a maximum of Chinese experts with "convenient and inexpensive exposure to the most advanced western technology," not only through access to exhibits, but also by "countless hours of technical briefings and seminars and vast quantities of free technical literature."[15] Canada was among the countries mounting technical exhibitions in China. In August 1972, the then External Affairs Minister, Mitchell Sharp opened the Solo Trade Fair in Peking, the largest such Canadian effort ever organized abroad.

The government's responsiveness to Chinese interest in Canadian science and technology was partly the result of a desire to expand trade and to bid for a share of the new China market. Between 25 June and 4 July 1971, a mission led by Industry, Trade and Commerce Minister Jean-Luc Pepin consulted with Chinese officials in Peking on matters relating to the development of commercial and economic ties, including the plan for a 1972 Trade Exhibition and the proposed launching, also in 1972, of an industrial-technical exchange program. In the first year of this program, China sent a team of experts to Canada for a 23-day tour of mining and metallurgical research facilities, plants, and exploration companies. Industry, Trade and Commerce also hosted a petroleum mission in 1972, with the Chinese demonstrating a particular interest in offshore exploration and pipelines. In December 1972, a third Chinese delegation spent two weeks in Canada studying electrical power. The tour included stops at the Churchill Falls hydro facility, Ontario Hydro's Lambton Thermal Power Station in Sarnia, and the Pickering Nuclear Power Plant, as well as visits to Canadian General Electric and Canadian Westinghouse, Dominion Engineering, Northern Electric, and CAE Industries. Two reciprocal industrial-technical missions in late 1972 and early 1973 involved both IT&C and EMR. One team of Canadian experts, headed by a senior official from Energy, Mines and Resources, spent three weeks in China examining the potential for cooperation in the metallurgical field and helping to promote the sale of Canadian mining equipment and techniques. A second, month-long mission in the field of petroleum technology was led by Donald MacDonald, then Minister for Energy, Mines and Resources. From these early beginnings, IT&C's technical cooperation program with China expanded to include exchanges in agriculture, fisheries and forestry technology, pharmaceuticals, transportation, consulting engineering, and many other fields.

Commercially based industrial-technical exchanges form only one part of Canada's general exchange program with China, a program that includes academic, cultural, and sports exchanges as well as cooperation in medicine and non-industrial science and technology. In 1974, for example, an exhibit of Chinese archeological antiquities was displayed at the Royal Ontario Museum. Canadian gymnasts and figure skaters performed in Peking, and Chinese athletes in volleyball, basketball, and boxing came to Canada. A Canadian media delegation also visited the Chinese in 1974, in return for a similar mission from China which had taken place the year before. In the field of medical science, nine Canadian physicians studied acupuncture analgesia for a month in the spring of 1974, and nine Chinese doctors came to Canada in the autumn to study neurophysiology, organ transplant, and artificial kidney techniques.

Two Chinese medical scientists also visited McGill University for a month, under the revived Bethune program. And as part of the 1974 program in non-industrial science and technology, Canada and China exchanged missions in fields such as forestry, laser research, crop science, and hydraulic and open-pit coal-mining techniques.

All of these exchanges – academic, athletic, cultural, scientific, and technical – were the result of an intense political interest in developing links with the Chinese. The Canadian government clearly expressed this interest in October 1970 through rejection of the "two-China" policy and recognition of the People's Republic of China as the sole legal government of China. A year later, the government also supported a resolution calling for the restoration of the right of the People's Republic to the China seat in the United Nations. In October 1973, after Prime Minister Trudeau had visited China, he reported to the House of Commons that the decision to reverse the long-standing policy of ignoring the People's Republic had been the right one, "because that immense country of talented and industrious people will have an increasing impact on world affairs, and because a strengthening and enriching of the bilateral relation between Canada and China can be beneficial to Canadians . . . . It is the aim of this government," the prime minister declared, for "those benefits [to] increase and continue."[16]

The task of strengthening relations with the People's Republic of China through the development of a general science and technology exchange program was initially coordinated by the Ministry of State for Science and Technology. From 3 to 20 November 1972, MOSST hosted an exploratory mission of seven officials from the Chinese Academy of Sciences, a group which also had stops in the United States, the United Kingdom, and Sweden on its itinerary. The Chinese scientific delegation visited research facilities in Vancouver, Winnipeg, Toronto, Montreal, and Quebec City, and talked with NRC and other government scientists in Ottawa, in order to establish the initial connections and to identify possible areas of mutual interest. A return mission, more than double the size of the CAS delegation and headed by Jeanne Sauvé, then Minister of State for Science and Technology, visited China from 19 September to 14 October 1973 to follow up and develop further the contacts made by the Chinese scientists. The Sauvé mission, which immediately preceded the prime minister's trip to Peking, resulted in Sino-Canadian agreement on the implementation of a regular series of science and technology exchanges. The proposed exchanges were announced during the course of the Trudeau visit, along with the plans for similar cooperation in the field of medical science and public health.

One indication of the political importance of a broadened relationship with China was the government's creation of a special fund, administered by MOSST, to launch the Chinese science and technology program and cover costs over the first two years. Although the science-based departments would have to make a commitment in terms of time and manpower, most would not be asked to carry out the exchanges at their own expense and at the sacrifice of domestic priorities. There were officials who believed, nevertheless, that some of the exchanges agreed upon during the Sauvé visit would be of scant value to Canada, and others who complained that the line departments had been inadequately consulted before the mission departed. Indeed, the composition of the Sauvé delegation suggests a primarily Ontario-Quebec biomedical group, lacking representation from the other provinces or from other fields

of science. Despite the importance of coal technology to both Canada and China, for example, the mission did not include an earth sciences expert. Industry representatives were also absent from the Sauvé delegation, a reflection perhaps of the fact that IT&C already had its Canada-China technical cooperation series underway and was proceeding autonomously.

A glance at both IT&C and MOSST-sponsored programs in 1975 outlines the scope and variety of Sino-Canadian exchange. Canada sent a five-person seismology mission to China in December 1975, after receiving a similar Chinese group the year before. The government and university seismologists who made up the delegation were the first Western scientists to visit the Haicheng area following the major earthquake of 1974, and China's recognized expertise in seismology, particularly in the study of premonitory phenomena, suggests that the exchange may have been one of mutual benefit. Canada also sent a veterinary medicine mission to China in 1975, and the group spent three weeks studying Chinese disease research, diagnostic procedures, and the acupuncture treatment of animals. A third MOSST-sponsored mission represented a departure from the usual format of short-term, fairly large exploratory delegations in selected fields. In this case, two Canadian scientists, an entomologist and a plant physiologist, visited China in November and December 1975 as consultants in the field of insect control to establish an exchange program of biological materials. Given the concern with modernization of the agricultural sector, biological control is an area of special interest to the Chinese. Six Chinese scientists had spent a month and a half in the United States in 1973 studying the applications of insect hormone research as a new alternative to pesticides, and a Chinese insect control mission also came to Canada in 1975.

A second Chinese mission to Canada that year studied various aspects of permafrost engineering, particularly in marginal areas with thawing conditions, and spent three weeks visiting NRC facilities in Ottawa as well as research centres at the University of Alberta, McGill University, École Polytechnique, and Mackenzie Valley Pipeline Research Limited. Other stops were scheduled for Ungava, Schefferville, Thompson, and Churchill. In September 1975, Environment Canada also welcomed a seven-member Chinese delegation in the field of fisheries research. IT&C's technical cooperation series in 1975 included the hosting of a Chinese railway industry mission in May and a high-voltage technology delegation in October and November. Another area in which the Chinese expressed keen interest was geophysical exploration. Barringer Research, Huntec (1970) Limited, McPhar Geophysics, Seintrex Limited, Exploranium Corporation, and Crone Geophysics had all participated in an April 1974 Canadian Electronics and Scientific Instruments Exhibition in Shanghai, and all cooperated with IT&C and EMR in receiving a Chinese geophysical mission in September 1975. Other manufacturing companies were also involved, as were service companies like Rio Tinto, Eagle Geophysics, Geoterrex, and Terra Surveys who could expect no commercial benefits but who were willing to assist on the basis of goodwill.

Since Sino-Canadian exchanges have not yet generated a sufficient measure of reciprocity, goodwill has been dissipating. Canadian officials expected that the Chinese would gain the larger scientific advantage, but had hoped for something more than the one-way flow that has been predominant. The anticipated commercial spin-off has also been slow to materialize. Canada has sold some telecommunications, railway, and other high-technology equip-

ment, but despite China's assurances "that it could easily buy from Canada manufactured products it now obtains elsewhere," other countries are still obtaining most of the orders. Although in 1973 Chinese officials presented Prime Minister Trudeau with the pleasing prospect of "turn-key" sales, none has yet come about. On the other hand, China has bought such complete industrial plants from Japan, the United States, and Western Europe. In fact, through 1975 and 1976, the last two years for which figures are available, the volume of Sino-Canadian trade has actually declined.[17] According to one observer, the Chinese "are remarkably conservative in their trading patterns and they will hardly be won away from the notion that the best sources of high-technology are the established leaders in the field . . . [Canada] can never aspire to more than a minor slice of the pie."[18]

With the 1975 transfer of the coordinating function from MOSST to External Affairs and the termination of the special funding arrangement covering the first two years of the program, the future course of Sino-Canadian science and technology cooperation came under governmental review. Policy makers began to seek ways of improving reciprocity by shifting the emphasis away from the four-to six-person, two-to three-week exploratory mission, and focussing instead on securing Chinese approval for the exchange of one or two individuals for longer periods of time, the more typical pattern in the successful medical exchange program. Attempts are now also being made to identify and concentrate on areas of Chinese expertise, where greater mutual benefits might be anticipated, and to generate proposals that are specific and very carefully defined and therefore more likely to receive Chinese approval. Financial constraints are restricting current programs to an absolute minimum number of exchanges. Problems of bureaucratic coordination, not only among participating departments but between Ottawa and the embassy in Peking, may be presenting additional difficulties. Dealing with the Chinese bureaucracy can sometimes be a source of frustration. Exchanges, except those in the medical field, must be negotiated through the Academy of Sciences rather than directly with the appropriate Chinese ministry. Nevertheless, it is generally agreed that efforts to date have accomplished one major objective: Chinese and Canadian scientists in various fields have come to know one another and exchanges have made a significant contribution to the overall strengthening of Sino-Canadian relations. Furthermore, in fostering cooperative programs with the People's Republic of China, Canada has acted in accordance with the international commitment undertaken by the industrialized nations to share part of their science and technological know-how with the countries of the developing world.

The Soviet Union and Eastern Europe

Canada's science and technology relationship with the Soviet Union and the Bloc countries began in the 1950s with the negotiation of bilateral trade agreements. Under these agreements, concluded over time with every East European country except Albania and the German Democratic Republic, various industry-specific technical exchanges began to take place. In announcing the 1966 renewal of the trade agreement with the Soviet Union (originally signed in 1956), the Trade and Commerce Department noted that the governments had "also renewed their undertaking to facilitate visits for business purposes between Canada and the USSR."[19] Similarly, after trade talks with Czecho-

slovakia in 1966 the press was informed that Czechoslovak authorities had "expressed an interest in exchanging visits of mining executives and engineers."[20] Trade and Commerce hosted an agriculture and farm machineries mission from Yugoslavia in August 1967, for example, and a Russian mission came to study automated oil field technology in November of that year.

The motivation underlying this activity was primarily an economic one. Canada, like other Western nations, perceived the growing market potential of Eastern Europe and undertook technical exchanges in anticipation of new commercial opportunities. Such exchanges were also in keeping with Western political goals. From the mid-1950s on, following a certain relaxation of Cold War tensions, the NATO countries generally sought to expand their contacts with the Soviet Bloc. Western officials were willing to trade a measure of scientific and technical information for the long-term benefits of improved relations with the USSR. They also hoped that Western development of economic and cultural ties with the East would encourage the Bloc countries to achieve greater independence of the Soviet Union. In this spirit, multilateral cooperation in scientific and technical fields also began under the auspices of the United Nations Economic Commission for Europe. And in 1959, both the National Academy of Sciences in the United States and the National Research Council in Canada signed bilateral agreements with the USSR, providing for non-industrial exchanges in various fields of pure science.

The willingness of Russian and East European political leaders to cooperate with the West in scientific exchange was, like their participation in industrial exchange, a function of their eagerness to acquire Western expertise. Indeed, once the exchange program with the Soviet Union had been undertaken, scientific academies in a number of East European countries approached NRC in the hope that they might be able to negotiate similar arrangements. Since these countries lacked the international status and the scientific achievements of the USSR, and since NRC had a limit to the resources it could devote to formal exchanges, Canadian officials resisted the pressure. Instead, East European scientists were encouraged to make informal visits and apply for NRC post-doctoral fellowships on an individual basis. The different divisions within NRC also carried on various kinds of *ad hoc* activities with counterparts in Eastern Europe when these were deemed to be of mutual benefit. The photogrammetry section of the Division of Physics, for example, has long been involved in a useful exchange of data, materials, and visits with the Stanislaw Staszic Academy of Mining and Metallurgy in Poland.

In an apparent gesture of sympathy, NRC did make an exception of Czechoslovakia. Following the 1968 Warsaw Pact invasion of that country, NRC initiated a small exchange program. As noted earlier, this Type IV agreement has not been regarded as a scientific success. Nevertheless, the arrangement was renewed in 1973. Terminating it would have run counter to the policy of detente, and in continuing the arrangement Canada helped lend credence to the expressed desire of the NATO countries to expand their scientific relations with the East.[21] The renewal of the NRC-Czechoslovak Academy Agreement may also have been rationalized, to a lesser extent, by commercial considerations. When a Canadian firm lost a microwave relay system contract in Czechoslovakia to Siemens of West Germany, there was some feeling that the difficulty might be attributed to the fact that the Czechoslovaks were not as familiar with Canadian technological accomplishments and expertise as they were with European. The presence of even a few Czechoslovak scientists

in Canada each year would offer the opportunity for increased contact and might help portray Canada as a potential supplier of technologically sophisticated equipment.

The Umbrella Agreements

The same commercial considerations acted overwhelmingly to prompt the negotiation and conclusion of the first of two Canada-USSR intergovernmental science and technology agreements. The Type I Agreement on Cooperation in the Industrial Application of Science and Technology signed in Moscow on 27 January 1971 was intended "from the outset" as a way of "identifying opportunities for commercial exchanges."[22] It was an outgrowth, expansion, and formalization of the industrial-technical missions that had taken place under the Canada-Russia trade agreements of the 1950s and 1960s. Although the language of the accord spoke very generally of developing "friendly relations" and encouraging "technical cooperation," the agreement was plainly regarded by the Department of Industry, Trade and Commerce as a "means of promoting Canadian technology in the USSR with a view to developing. . .an appreciation of Canadian capabilities and ultimately a market for Canadian capital equipment. . . ." Canada's objective, according to IT&C, was "to provide for exchanges in those areas where, because of similarities of geography, climate and resources, Canada has developed unique skills in technology which would be saleable to the USSR. . . ."[23]

The Russians also sought to better their trade opportunities, but their primary objective was to gain access to Canadian technology and know-how. The Soviet Union had already signed similar agreements with France and Italy in 1966, Britain and Austria in 1968, Belgium in 1969, and Sweden and Denmark in 1970. The agreement with Canada was modelled on the Anglo-Soviet accord and established a Mixed Commission which would meet annually for the purpose of reviewing existing programs and proposals for new cooperative efforts. The Canadian side of the Commission was chaired by the Minister of Industry, Trade and Commerce, with the rest of the delegates being drawn from business associations and from the senior levels of those government departments interested in implementing the agreement. Canadian members of the first, 1971 Mixed Commission included representatives from Industry, Trade and Commerce, External Affairs, Energy, Mines and Resources, the Ministry of Transport, the Department of Public Works, Indian Affairs and Northern Development, the National Research Council, the Science Secretariat, the Canadian Chamber of Commerce, the Canadian Manufacturers Association, and the Canadian Export Association. Joint working groups were set up by the Mixed Commission to study the potential for cooperation in architecture and the construction, transportation, electrical, agricultural, oil, gas, forest-based, and non-ferrous metals industries. Each working group was co-chaired by a Canadian deputy minister from the appropriate government department, with the rest of the Canadian side primarily composed of representatives from the private sector. In 1971, the following industries and industrial associations were among those participating: Domtar Construction of Montreal and ATCO Industries of Calgary; Canadian National Railways and Sicard Incorporated of Ste. Thérèse, Quebec; Northern Electric and Canadian Westinghouse; the Canadian Petroleum Association and the Coal Operators Association of Western Canada; Sandwell and Company of Vancouver and Sherritt-Gordon Mines Limited, Toronto. Three new working groups were

created in 1976 to examine the possibility of additional cooperative activity in the industrial applications of geology, coal, and ferrous metals as well.

In a 1974 study undertaken by I. A. Litvak and C. H. McMillan, a number of government and industry participants were interviewed after the agreement had been in force for three years to determine the extent to which Canadian objectives had been realized. Businessmen pointed out two benefits. First, by establishing a framework for exchange tailored to the Soviet bureaucracy, institutional barriers had been reduced. Canadians had become personally acquainted with the important decisionmakers in the USSR's production sector, through visits to each other's plants and factories and through meetings of the Mixed Commission and working groups. Secondly, Canadian firms had been able to secure more reliable and comprehensive data on the requirements of the Soviet market. Yet while conditions for trade had improved, the study adds that "it would be difficult to link one major sale of Canadian goods or technology to the agreement in its 'three year plus' life span." Nevertheless, as Litvak and McMillan state, there is always a "significant lag" between negotiation and sales in commercial exchanges with the USSR particularly in the area of capital goods and high-technology products. In their view, the best indicator of commercial results will be the volume of trade under the 1976–1980 Five Year Plan.[24]

Non-grain exports to the Soviet Union did increase between 1974 and 1975, with Canadian suppliers of large off-highway vehicles, forest-harvesting equipment, and components for heavy processing industries securing substantial contracts.[25] Although ITC officials have not declared a direct connection between recent sales and the Soviet accord, the agreement was renewed in 1976 for a further five years. At the same time, Canada signed a financing protocol to provide the Russians with a $500-million line of credit for the purchase of capital goods. Litvak and McMillan argue, however, that the umbrella is a technological exchange, not a commercial agreement, and to view it solely in the latter terms is short-sighted and self-defeating. They suggest that Canada move on past the get-acquainted and trade-development phases to undertake the sort of large-scale joint industrial projects that are of "significant duration, involve major technology transfers, and increase the stability of trade between the Eastern and Western partners."[26] As Canadian officials have recognized, there are areas of Soviet expertise – for example, advances in fisheries technology, steel production, and power transmission – from which Canadian firms could benefit.

Thus commercial, and to a lesser extent technological, considerations motivated the signing of the Canada-USSR Agreement on the Industrial Applications of Science and Technology. But there was also a political rationale. Scientific and technical exchanges with the Russians had been suspended in 1968 and early 1969 following the Soviet invasion of Czechoslovakia. For example, the planned participation of Russian foresters in the Canadian Institute of Forestry Convention was cancelled, as was a visit by Canadian industrialists to Russian aluminum plants. The Industrial Applications agreement, negotiated through the latter part of 1969 and 1970, offered a practical indication of Canadian interest in both the public and, importantly, private sectors in resuming contact. Prime Minister Trudeau had been expected to sign the accord on the occasion of a projected state visit to the Soviet Union in the fall of 1970.[27] Perhaps some significance was lost when the visit was postponed and Jean-Luc Pepin, then Minister of ITC, acted as signatory, but

the agreement still symbolized a new era of greatly expanded bilateral relations.

A second symbol of the new era was formally concluded in Ottawa on 20 October 1971 when Premier Kosygin and Prime Minister Trudeau signed the Canada-USSR General Exchanges Agreement. The origins of this second intergovernmental Type II umbrella accord lie alongside the origins of the first – in Cabinet's 1966 approval of a recommendation that Canada proceed toward a general agreement with the Soviet Union on exchanges in cultural, scientific, technical, educational, and other fields. Work on a draft was halted after the invasion of Czechoslovakia, but was resumed again just prior to Foreign Minister Gromyko's visit to Canada in October 1969. While Canada pressed for an all-encompassing exchange agreement, the Soviet Union sought an accord limited to scientific and industrial cooperation. A compromise produced two agreements, the one on industrial exchange discussed above, and one that mixed the purely scientific cooperation valued by the Russians with the cultural activity of more interest to Canada.

Four articles in the text of the General Exchanges Agreement referred to the encouragement and facilitation of "contacts and exchanges" in the specific fields of agriculture, fisheries, wildlife, forestry, water, mining, energy, transport, communications, urban development, northern development, environmental management, pollution control, medical sciences, and public health, ". . .particularly in areas where geography and climate create similar conditions and problems."[28] An additional six articles referred to exchanges in education and athletics, in the performing, visual, and creative arts, and in the various forms of the communications media. The agreement also brought under its umbrella existing interagency exchanges, such as those concluded by Canadian universities, the CBC, and government departments, with Article II specifying that the texts of the AECL and NRC understandings be annexed to the general accord. As in the case of Canada's other umbrellas, a Mixed Commission was set up as the implementing mechanism, with meetings to be held every two years for the purpose of reviewing existing programs and developing new ones. A Protocol on Consultations, signed by Trudeau and Kosygin during the prime minister's visit to Moscow in May 1971, provided an additional mechanism whereby Canada and the Soviet Union could discuss, up to the highest level if necessary, problems arising in the implementation of both the earlier agreement on Industrial Applications and the framework on General Exchanges.

The agreements were intended to complement each other, with the second designed to cover all the fields of exchange not included in the first. Both created administrative machinery structured to cope with the Soviet bureaucracy, and patterned after similar agreements already concluded by the USSR with most of Canada's European allies. Like the Industrial Applications agreement, the General Exchanges umbrella has been successful in the facilitative sense. Without it, Canada could not have initiated, developed, or expanded bilateral contacts in so many different areas of endeavour. These contacts and the various co-operative activities generated under the umbrella have been politically beneficial, contributing to the normalization of relations between Canada and the Soviet Union and to the general Western goal of detente. In addition, some difficulties, particularly in the cultural field, encountered in the earlier period of less formal exchange have been eased. From a scientific standpoint, however, Canada appears to have gained little. Reciprocity, particularly in terms of access to information and sometimes in terms of the

calibre of personnel and facilities, was frequently a problem under the inter-agency understandings of the 1960s and it remains a problem under the umbrella. The science-based departments, which have the major responsibility for initiating and implementing joint activities, have not received a return commensurate with their investment in time and manpower. External Affairs has helped with funding, but from the perspective of the technical departments, the General Exchanges agreement with the Soviet Union seems like the umbrellas with Belgium, France, and West Germany – a frequently unfortunate drain on scarce resources.

Other Forms of Cooperation

Through 1971 and 1972, following the conclusion of the two Russian agreements, a number of Soviet Bloc countries revealed their interest in arranging similar umbrellas with Canada. This type of accord had begun to proliferate internationally, and the East Europeans had already negotiated many. Czechoslovakia signed an Agreement on Cooperation in the Field of Applied Science and Technology with Britain in 1968, after concluding a similar one with Denmark in 1966. Romania also signed a science and technology agreement with Britain in 1968, plus one with West Germany in 1969, and another with the United States in 1971. Yugoslavia also had an umbrella with the United States. Hungary had one with Denmark, and Poland had one with France. Some Canadian officials responsible for the conduct of Canada's economic relations with countries in the Bloc argued that Canada should follow the pattern to stimulate trade. Without science and technology agreements, most East European bureaucracies were hard to penetrate and it was the bureaucracies, rather than the end users, who made the decisions on imports. The same officials also believed that the deliberations of a Mixed Commission would help Canadian businessmen determine the requirements of the market, as in the case of the Soviet agreement. But other Canadian policy makers, while concurring with the view that there were commercial benefits to be gained, seemed to think that available resources were already fully committed. For the time being at least, Canada preferred to concentrate on developing formal and informal science and technology relations with nations enjoying a higher priority than those of Eastern Europe. Therefore, when a Czechoslovak technological delegation came to Canada in May 1971 at the invitation of the then ITC Minister Pepin, the 17-day visit was described only as a reflection of "the desire of both countries to exchange information on the application of advanced technology. . . ."[29] There were no references to future exchanges or promises of intensified cooperation.

On the occasion of President Tito's visit to Canada in November 1971, however, External Affairs Minister Mitchell Sharp and Foreign Affairs Secretary Mirko Tepavac did sign an Exchange of Letters to promote further Canada-Yugoslav relations in science and technology. This form of Type I agreement contained none of the obligations exacted by an umbrella, nor did it necessarily demand a Canadian initiative in seeking out possible areas of collaboration. But it did require a Canadian response to any proposals that might be put forward by the Yugoslavs. Thus the latter, who might have preferred a more formal arrangement, were at least able to secure a written expression of Canada's intention to encourage, "on the basis of reciprocity and mutual benefit," contacts and exchanges in science, technology, and its industrial applications.[30] Canada's willingness to conclude this understanding appears to have

been centred solely on political considerations. The underdeveloped state of Yugoslav science and technology suggested little potential benefit for the technical departments. A commercial motivation also seems unlikely. Yugoslavia was already Canada's largest market in Eastern Europe for commodities other than grain, and the autonomous status of Yugoslav enterprises argued against the need for an intergovernmental arrangement to help penetrate the system or boost interfirm cooperation. On the other hand, there was an obvious political advantage to acknowledging, during the course of Tito's visit, Yugoslavia's interest in expanding cooperation with Canada. Article VI of the Canada-Yugoslav Trade Agreement, signed two years after the Exchange of Letters, reaffirmed the intent to promote "technical cooperation," but neither accord appears to have generated much activity.[31]

Generally, the Canadian government has tried to avoid making formal science and technology commitments to the nations of the Soviet Bloc, while responding to individual proposals on an *ad hoc* basis and encouraging various kinds of governmental and non-governmental informal activity. In 1972–1973, for example, McMaster University undertook a cooperative program in both the natural and social sciences with the Hungarian Institute for Cultural Relations. Over the same term, NRC post-doctoral fellowships were accepted by researchers from Poland, Hungary, and Bulgaria. IT&C has continued to sponsor technical exchanges, and there are cooperative industrial arrangements like the 1969 accord between Polysar Limited and the USSR State Committee for Science and Technology, and the 1974 tripartite agreement among Kaiser Resources Limited of Canada, Mitsui Mining Company of Japan, and the USSR Ministry of the Coal Industry. The Canada Centre for Remote Sensing recently trained Polish scientists in a program that developed out of NRC's links with the Polish Board of Geodesic Cartography and IT&C's export promotion of electronic equipment for image processing. Some scientific and technical cooperation with Eastern Europe also takes place through multilateral forums. Canada, Russia, and other nations, for instance, participate in international oceanographic programs like IGOSS (Integrated Global Oceans Stations System) and POLEX (Polar Experiment) which provide for the exchange of marine data. Through the United Nations Economic Commission for Europe, Canada has been involved with Romania, Bulgaria, and other countries in the Committee of Senior Advisors on Science and Technology and the Committee of Senior Advisors on the Environment. Their meetings, seminars, and symposia offer participants an opportunity for contact and a certain amount of exchange.

The Conference on Security and Cooperation in Europe

The Final Act of the Conference on Security and Cooperation in Europe (CSCE), signed at Helsinki on 1 August 1975, placed new pressures on Canada to develop cooperative relations in science and technology with countries in the Soviet Bloc. By the agreement, 35 national leaders proclaimed their intent "to broaden, deepen and make continuous and lasting the process of detente." Under the Basket II provisions for cooperation, the participating states pledged "the improvement of opportunities for the exchange and dissemination of scientific and technical information," the facilitation of "international visits of scientists and specialists," and the wider use of commercial channels and activities for applied scientific and technological research and for the transfer of achievements attained in this field."[32] The CSCE Final Act specified the

areas of physics, chemistry, oceanography, hydrology, meteorology, seismology, glaciology, agriculture, energy, space, medicine, and computer technology as examples of fields where there was a potential for expanded scientific and technological cooperation. In a section on environmental problems, the Helsinki accord also cited the control of air and water pollution, the protection of the marine environment, land utilization, conservation, and environmental monitoring, forecasting, and assessment as examples of areas where participating states would "make use of every suitable opportunity to cooperate."

Other than the Albanians, who had not attended the conference, the East Europeans generally regarded the Basket II provisions as an opportunity to gain improved access to Western science and technology. In approaching Canada, several Bloc countries again tried to arrange their preferred facilitative mechanism – the formal, intergovernmental general science and technology agreement. Some of the science-based departments were worried by the possibility that the Helsinki accord would mean the imposition of new obligations that they could not afford to meet, but Canada avoided concluding any additional umbrellas. Instead, the Bloc countries were encouraged, as before, to bring to the attention of the Canadian government concrete proposals or specific suggestions for cooperation. These might then be judged on their individual scientific or technological merit and acted upon accordingly. Although Canada felt a moral and political commitment to implement the CSCE, phrases like "mutually advantageous" and "mutually beneficial," which had been sprinkled through the text in the sections on cooperation in the Helsinki agreement, gave the government some leverage. The technical departments would not necessarily be expected to spend time, money, and effort on joint activities of value to the East Europeans, but of little or no significance to departmental programs.

The Canadian government may be obliged, nevertheless, to show some evidence of a broadened science and technology relationship with the East Europeans whenever the matter comes up for international review. The Final Act provides for follow-up meetings to encompass a "thorough exchange of views" on the implementation of the CSCE, on the "deepening of . . . mutual relations," and on the "development of cooperation."[33] The first of these meetings, held at Belgrade through the autumn and winter of 1977–1978, conceded the "difficulties and obstacles" of implementing the CSCE, but the participants also "stressed the importance they attached to detente," and "reaffirmed the resolve" of their governments to carry out "fully, unilaterally, bilaterally and multilaterally all the provisions of the Final Act." The next steps in follow-up to Helsinki included a summer 1978 "meeting of experts" in Bonn, Germany to discuss the creation of a "scientific forum," and a similar meeting in Malta is being planned for 1979, "to consider the possibilities and means of promoting concrete initiatives for mutually beneficial cooperation. . ." according to the provisions of Basket II.[34]

Poland is one country that benefitted from the CSCE in terms of an expressed interest by Canada in expanding science and technology relations. Between 29 September and 4 October 1975, two months after the Helsinki agreement had been signed, External Affairs Minister Allan MacEachen visited Poland. A Joint Communiqué issued by MacEachen and Polish Foreign Affairs Minister Stefan Olszowski proclaimed that the two men had "agreed to explore scientific proposals which might arise" in the area of scientific and technological cooperation. They had also "agreed to encourage and promote

further cooperation and contacts" between universities, scientific and research institutions, and individual scientists.[35] The communiqué indicated that Canada was not prepared to conclude a bilateral science and technology agreement with Poland, but did seek to develop the relationship on a more informal basis. Canada's expressed interest in Poland may also have been conditioned by commercial factors. In July 1975, the pulp and paper concern of H. A. Simons (International) Limited of Vancouver signed a $50-million contract with Polimex Cekop of Poland to build the Kwidzyn Forest Products Complex. In spite of Poland's increased economic importance to Canada, and a political rationale based on the CSCE, the science-based departments and agencies of the federal government were reluctant to support the expansion of Polish-Canadian scientific and technological relations. The composition of a May 1977 Canadian government science and technology delegation to Warsaw suggests the technical departments' lack of interest. This four-person exploratory mission, sent in accordance with the MacEachen-Olszowski discussions and the principles enunciated by the CSCE, was made up of representatives from the Science Council of Canada, the Ministry of State for Science and Technology, McGill University, and External Affairs, but included no specialist-experts from the government's science-based agencies.

In testimony before the US House of Representatives, Allan Kassof, Executive Director of the International Research and Exchanges Board, discussed the "thoroughly demonstrated" and "well understood" fact that

> "exchanges with Eastern Europe and the Soviet Union have gone very far towards reducing the isolation and restrictions on foreign contacts imposed . . . during much of the post-World War II period. That achievement is universally welcomed by those who understand the essentially transnational nature of scholarship and learning . . . and who are aware of the need for full international participation in the division of scientific labor as we grapple with complex problems . . . ."[36]

From the diplomatic perspective, Dr. Kassof added, "such cooperative undertakings have fostered habits of working together . . . with favorable consequences for mutual understanding at the political level as well." Most Canadians in the scientific and foreign policy communities would support Kassof's view. In contributing to detente with the Russians, in helping pluralism and a certain degree of autonomy develop in Eastern Europe, and in furthering the integration of the international scientific community, Canada's exchanges with the Soviet Bloc have served a number of very broad objectives.

There are those who believe, however, that some of Canada's more specific national interests have not been so well served and that, overall, the costs have outweighed the benefits. Scientific and technological cooperation, whether through the formal structure of the Russian umbrellas or through the various kinds of informal arrangement, appears to have had little effect, so far, in stimulating the anticipated trade. Indeed, the case of Poland, in which a major commercial transaction took place before a promise of increased cooperation and before an exploratory mission, suggests a reversal of the usual perspective. Instead of Canadians expecting trade benefits from cooperation in science and technology, East Europeans might expect science and technology benefits to come from trade. In addition, the formal agreements with the Soviet Bloc countries have proved to be, by and large, administratively cumbersome, time-consuming, and expensive to implement, yet no more productive than less formal arrangements. Informal cooperation, however, also pre-

sents disadvantages. Since the East European bureaucracies are so highly centralized and appear to be growing more interdependent in terms of science and technology planning, responding on an *ad hoc* basis makes the problem of one-way transfer more difficult to control. Moreover, the variety of interagency exchanges being carried out by government departments like NRC, IT&C, AECL, and EMR, and the number of multilateral activities taking place in international organizations, of private sector cooperative projects involving university researchers or industries, and of provincial interactions, make the monitoring process difficult. And without a monitoring mechanism, decision makers are confronted by an insufficiency of the data needed to make informed judgements on the value to Canada of science and technology relations with the Soviet Bloc.

Some of the problems encountered in the agreements with Russia and Eastern Europe can be attributed to differences in language and operational style, in social, political, and economic systems. These difficulties may be ameliorated over time, as each bureaucracy accumulates more experience in dealing with the other. There could also be a potential for mutually beneficial real science and technology cooperation somewhere in the future, and a potential for commercial and economic gain. At the present time, it seems clear that there are important political objectives. As stated in the government's 1970 White Paper, Canada seeks to strengthen relations with Europe, both West and East. Canada also has a responsibility in the international community to try to implement the Basket II provisions of the CSCE. Despite current strains in East-West relations, Cuban adventurism in Africa, and the issue of Soviet dissidents, External Affairs Minister Donald Jamieson has affirmed Canada's commitment to detente. In the early months of 1978, the Canadian government expelled Soviet Embassy officials, and cancelled a Jamieson visit to Moscow, yet the External Affairs Minister also recently declared that "without detente, the prospects for a deterioration and therefore for global conflict would be very real indeed . . . . A world in which there are two solitudes would be disastrous."[37] And, as C. H. McMillan has noted, "Canada can scarcely turn her back on opportunities to develop and improve relations with the world's second largest economy," an economy that also shares with Canada "many geographically and climatically based problems in the area of resource development, continental transport and communications and related industrial technology."[38]

Yet intergovernmental cooperation in science and technology with the Soviet Union and the countries of the Bloc cannot take place without the support of the technical departments. Like their Canadian counterparts, American government agencies have sometimes been reluctant to commit resources to programs of political benefit but of scant scientific value. A recommendation by Dr. Allan Kassof, made in the course of his testimony before the Congressional hearing on Soviet American cooperation, might also be considered by Canadian policymakers:

> "In the future the bilaterals ought to be centrally funded, to the extent that this is a realistic possibility. It is poor procedure to sign agreements and then look for the wherewithal to carry them out. It obliges the participating agencies to compete against their own domestic projects to come up with appropriate budgets, and distorts priorities."
>
> "If we are going to have intergovernmental cooperation and exchanges,"

Kassof suggests, "then we ought to be willing to decide what it is worth to us, and to set aside the essential resources in advance."[39]

The Traditional Relationships

Britain

In discussing the planned development of science and technology relations with Europe, the 1970 White Paper noted that "traditionally, Canada's closest links in this field have been with Britain . . . ."[40] For years, the National Research Council and Defence Research Board had representatives on the staff of the Canadian High Commission. In 1969, a science counsellor was also appointed. Working-level contact between other government science-based agencies is extensive. Government and university scientists are further linked through non-governmental organizations like the Royal Society, intergovernmental institutions like UNESCO or the World Health Organization, and in a variety of Commonwealth forums. Indeed, Canadians have generally taken for granted the existence of a vast, informal Anglo-Canadian scientific network – a free-flowing exchange fueled by various "old-boy" connections, and characterized by numerous beneficial interactions.

The traditional scientific tie with the United Kingdom has been beneficial, but perceptions of its scope are not entirely accurate. Joint projects have been undertaken in the field of defence R & D, yet a closer look at liaison in the civilian sector reveals remarkably little in the way of significant cooperative research. Twenty-seven Canada-United States area- or project-specific agreements are listed in Appendix B, but there is not one equivalent agreement with Britain. By and large, the volume of scientific exchange is misleading. It indicates not an intensity of collaboration but a diffusion of effort across a wide spectrum which has not been especially meaningful in practical terms. The reason lies in post-World War II shifts in the global politico-economic structure. In the years since 1945, as Britain declined in great power status, the Commonwealth bond was weakened. Successive British governments developed an ever-increasing commitment to integration with Europe, and Canada grew correspondingly closer to the United States. In 1973, Japan replaced Britain as Canada's second single largest trading partner. Britain remained Canada's second most important ally, but continentalism and regionalism had worked together to diminish the substance of the Anglo-Canadian science and technology relationship.

A flurry of high-level, science and technology-related visits in the early 1970s suggests that the Trudeau government sought to counter the trend. Conversations held in 1970 in London between Industry, Trade and Commerce Minister Jean Luc Pepin and his British counterpart included a discussion of the potential for closer cooperation, particularly in the area of applied science and industrial technology. A senior official from MOSST stopped in London in July 1972 for informal talks, and his visit was returned in October by the chief of the International Collaboration Unit at Britain's Department of Trade and Industry. A year later, Jeanne Sauvé, Minister of State for Science and Technology, travelled to England for a meeting with Margaret Thatcher, then Secretary of State for Education and Science. The aim of the visit, according to a MOSST communiqué, was "to strengthen links between Britain and Canada in . . . science and technology, and to explore means of increasing cooperation . . . ."[41] Sauvé and her party visited

the Scott Polar Institute, Turbomachinery Laboratory, and Computer Aided Design Centre, and discussed oceanography, Arctic science, and space with officials in appropriate British government agencies.

The attention directed toward Britain in this period paralleled the initiatives being taken to develop or expand science and technology relations with a number of other countries. It indicates that officials were contemplating the idea of lending further structure to the relationship with Britain, perhaps by means of a more formal mechanism for collaborative activity. Everyday contacts functioned well, but officials seemed concerned with the absence of bilateral planning at the policy-making level. If working groups were established, reporting perhaps to an existing, regularized, general discussion forum like the Canada-United Kingdom Continuing Committee, then additional Anglo-Canadian government-industry links might be fostered, leading to joint ventures in one or more areas of complementary expertise. Such areas could include marine technology, long-distance transmission of electricity, environmental control systems, STOL and VTOL development, advanced communications systems, or computer technology.

Canada's interest in buttressing ties with the United Kingdom derived from concern over British accession to the European Economic Community. As the White Paper noted, "the entry of Britain and its EFTA associates [Ireland and Denmark] into the Common Market will affect Canada's traditional access to these markets. . . .[and] important Canadian trade interests."[42] Not only was there specific worry over the fate of agricultural and industrial exports to Britain, "there was also a general fear," one analyst observed, "that this represented a new step toward a world of trade blocs in which Canada's choices would be few and unpleasant."[43] A like concern evolved over signs of an emerging European science and technology community. For example, according to a 1971 British press account, a "new era" in cooperation was implemented when Britain agreed to participate in the establishment of a pilot European computer-to-computer network, and to carry out four intergovernmental agreements concerned with metallurgical projects and antipollution measures.[44] Canadian officials began to see themselves as being closed off from access to British skills and expertise, and British capital and markets – indeed, as being frozen out of Europe. The government had already moved to develop science and technology relations with the EEC through individual approaches to member nations like Germany, France, and Belgium. Enhancement of the existing link with Britain would be a logical accompanying step, and would fit in with the Third Option – the need to establish a European counterweight to the influence of the United States.

For a time it seemed that Britain and Canada might enter into partnership in the field of nuclear energy. In late 1973 and 1974 there was some expectation that Canada would be able to capitalize on a long history of Anglo-Canadian nuclear exchange and sell CANDU to Britain.[45] The hope did not materialize. Canada and Britain were not able, either, to develop joint collaborative projects in other advanced sectors. Despite Canadian initiatives, scientific relations remained as they were: diffuse, informal, and unstructured. They were useful on the interagency, individual working level, but insubstantial when compared with the volume and depth of American interchange. In 1974, the National Research Council closed its office in London, and the High Commission's science counsellor melded NRC interests with those of others in the government's science community. A shift to apparent satisfaction

with the status quo may have reflected the fact that Canada and Britain were both feeling increasingly burdened by the accumulation of formalized science and technology commitments to other countries. The worry over entry to the Community had also become less pressing as new Euro-Canadian links developed. In face of numerous, expensive, and time-consuming involvements elsewhere, it seems likely that officials eventually came to regard the traditional, *ad hoc* form of exchange with British counterparts as sufficient.

Other Commonwealth Ties

Canada and Britain also participated in multilateral exchanges of scientific and technical information under the aegis of Commonwealth organizations like the Committee on Mineral Resources and Geology, Commonwealth Agricultural Bureaux, and Commonwealth Scientific Committee. Over time, the content of these exchanges grew progressively less relevant to direct Canadian or British interests, and more and more devoted to the needs of Commonwealth developing countries. In the 1950s, under the Colombo Plan, Canada transferred nuclear technology to India, built a reactor in Pakistan, and provided both the financing and expertise for a number of capital projects in other technological sectors. In the 1960s, technical assistance was also extended to Commonwealth countries in Africa and the Caribbean. In the 1970s, Commonwealth science and technology relations are still primarily concerned with aid. On the occasion of Indira Gandhi's visit to Ottawa in June 1973, there was a suggestion in the prime ministerial communiqué that the association with India had matured to the point where it was "desirable to initiate a review and renewal of bilateral relations. . .in economic, cultural, scientific, technical and commercial exchanges." However, despite a subsequent meeting of "senior officials. . .for detailed discussions, including possibilities for joint economic ventures," science and technology "exchanges" with India have remained within the realm of development assistance.[46]

Australia is the only Commonwealth country with which Canada has signed non-aid-oriented science agreements. Nuclear cooperation dates back to 1959, and scientific and technical exchanges in other areas are implemented through a variety of bilateral and multilateral channels. In its 1970 White Paper, the government predicted a considerable expansion of Canada-Australia science and technology relations. Canada, as an advanced country and a Pacific power, "wishes to forge closer scientific and technological ties with the Pacific countries," promote collaborative endeavours, and in particular, "explore the possibility of . . . Canada-Australia cooperation in communications satellite research."[47] The Commonwealth bond, and geographical and other similarities, did suggest strong potential advantages in a cooperative effort, not only in communications but also on environmental matters, in arctic/antarctic research, agriculture, and other resource areas. However, apart from a 1975 space agreement allowing NRC to use the Woomera rocket range for ionospheric investigation of the southern hemisphere, exchanges with Australia have proceeded without benefit of formal arrangements and the volume has not greatly increased. NRC has an informal understanding with the Australian Academy of Sciences. The Geological Survey division of Energy, Mines and Resources has long carried out a useful exchange with the Australian Bureau of Mineral Resources. The latter program, in permitting the trade of scientific personnel through work-transfer arrangements,

is a model form of Canada-Australia interagency cooperation emulated by other science-based departments.

The United States

The overwhelming proportion of Canada-United States cooperation in science and technology is carried out in similar fashion, through informal exchanges of information and personnel. Twenty of the 27 Canadian-American Type III agreements listed in Appendix B pertain to space, and are representative of the collaborative effort in that sector, but the remaining number comprises only a tiny fraction of cooperation in other fields. Agreements with the United States are usually considered necessary only when there are important legal considerations, large financial commitments, or major policy implications. The great bulk of scientific and technical exchange takes place on an *ad hoc*, highly informal basis.

Canadian-American associations in science and technology are so pervasive and the network so extensive that a catalogue of bilateral governmental relations, quite apart from the enormous volume of multilateral, state-provincial, industrial, university, or other private sector links, would seem to defy compilation. In 1972 and 1973, nevertheless, the Ministry of State for Science and Technology undertook the task. In assessing the extent and nature of the relationship, MOSST produced a comprehensive, 90-page report that details bilateral boards, commissions, committees, or other bodies having planning, advisory, or regulatory responsibilities of a scientific or technical nature; cooperative research and development programs; joint participation in scientific or technical facilities; scientific and technical information exchanges; support of non-governmental projects and organizations; and other cooperative associations of a continuing nature, like liaison officers or joint training programs. To correct deficiencies and keep abreast of new developments, MOSST intended to conduct regular annual reviews. With the ministry's 1975 reorganization, and hence the demise of the responsible Bilateral Cooperation Division, the reviews did not take place. An effort was made to up-date the MOSST survey for the purposes of this report, and the results on agreements are itemized in Appendix B. Limitations of space preclude a similar compendium of informal Canadian-American arrangements, but a glance at the activities of just one science-based department – Energy, Mines and Resources – may suggest the scope of the exchange.[48]

The Mines Branch of EMR is represented on some 35 committees of the American Society for Testing Materials (ASTM). According to the MOSST survey, ASTM committees "review methods of standardizing materials and testing procedures and initiate experimental work to test various methods" in numerous areas such as "metal-bearing ores and related materials. . .coal and coke, peat, non-ferrous metals and alloys, copper and copper alloys, etc." Scientists at the Mines Branch also carry out an informal exchange of data and personnel with the US Bureau of Mines in areas like mine-fill technology, rock mechanics, platinum analyses, and coal and coke technology. The Mines Branch further cooperates with the US National Bureau of Standards, and even exchanges information with the US Armed Forces, usually indirectly, through National Defence or a Canadian company. In the field of seismology, EMR daily sends data to the US National Oceanographic and Atmospheric Administration (NOAA) "in order to contribute to immediate determinations of earthquake epicentres," as well as to ascertain Canadian access

to "approximately 20 times more information than supplied. . . ." EMR also exchanges magnetic survey and magnetic observatory information with the US Department of Commerce. The Earth Physics Branch has an ongoing arrangement with the US Defense Mapping Agency in the exchange of gravity data, and EMR's Surveys and Mapping Branch is involved with the US Department of the Interior in "exchanges of information and visits to discuss subjects of mutual interest in control surveys. . .cartography, etc."

Cooperative research and development programs include various oceanographic projects executed by EMR and the Bedford Institute in Canada with US research institutes like the Lamont-Doherty Geological Observatory, Woods Hole Oceanographic Institute, University of Washington, John Hopkins University, and government agencies like NOAA, the American Navy and Coast Guard, the US Geological Survey, and the Coast and Geodetic Survey. Scientists at EMR's Geological Survey cooperated with NASA (National Aeronautics and Space Administration) in the analysis of lunar samples. The Geological Survey also collaborates with the US Department of the Interior in marine geophysical studies of binational waters in the Strait of Juan de Fuca. In fact, according to the MOSST compilation, most of the scientists at the Geological Survey are involved in one way or another in joint research programs with their counterparts in American universities, industries, and government. Eighteen ongoing projects in 1972 and 1973 are listed by MOSST and include: fossil consulting services to the University of California; separate Devonian rock studies with the University of Massachusetts and Mobil Oil; Pacific coral reef studies with the University of Hawaii; oxygen isotope analyses with Marathon Oil; micrographic studies of Mississippian brachiopods with the Carnegie Institute; and different biostratigraphic studies of fauna with Washington State College, American Oil Corporation, University of Iowa, and the US Geological Service. Since 1964, the Geological Survey has also participated in the JOIDES program (Joint Oceanographic Institutions for Deep Earth Sampling), a collaborative study of cores obtained from deep ocean drilling.

EMR's Polar Continental Shelf Project additionally provides scientific personnel and logistical support for a number of other research programs, sometimes carried out with Canadian universities, research institutes, and other government agencies, but generally always in collaboration with American counterparts. One of the more important is AIDJEX (the Arctic Ice Dynamics Joint Experiment), a multidisciplinary, multiinstitutional Canadian-American investigation of the dynamic behaviour of sea ice. Other projects have investigated glacial and post-glacial geological history, tundra ecology, and arctic climatology. In the non-nuclear energy field, EMR conducts a regular exchange of personnel and information with ERDA, the US Energy Research and Development Administration. A highly significant and valuable scientific-technological interchange also takes place among the staff of EMR's Canada Centre for Remote Sensing and colleagues at NASA.[49] Finally, Canadians at EMR have frequent opportunity to interact in a professional capacity with Americans in their field through any number of multilateral forums. In one of the more interesting intergovernmental examples, Canadians and Americans have worked together in NATO's Committee on the Challenges of Modern Society to pinpoint energy-efficient technologies and management practices that are transferable within the international steel, cement, plastic, and brewing industries.

The Third Option

This catalogue of one federal agency's science and technology relationship with the United States could be repeated in like measure by the Departments of Agriculture, Transport, Communications, Health and Welfare, Environment, and others. The volume of exchange is staggering. The benefits to Canada are enormous. The background to, and case study of, the space shuttle agreement with the United States plainly illustrates the advantages to Canada of space cooperation. Similar benefits accrued in many, many other sectors. As the Trudeau government recognized, the Canadian-American relationship "has been a rewarding and enriching [one] . . . on most counts. In particular . . . it has been instrumental in endowing Canadians with an industrial structure and the higher standard of living that goes with it in a shorter time span than might otherwise be achievable . . . ."[50]

On the other hand, the government also perceived certain costs:

> "Largely because of the close industrial ties with the United States economy, the pattern of research and development in Canada has differed from that of most advanced countries. With certain notable exceptions [atomic energy], the application of technology in Canada has been largely the product of "branch plant" relationships . . . with the result that, generally speaking, extensive research and development in Canada has been curtailed. The heavy impact of United States technological activity has tended to inhibit any substantial domestic effort within Canada and to drain scientifically-oriented Canadians away from this country. Individuals, companies, and educational institutions all seem to draw most of their scientific and technological sustenance from the United States."[51]

"It is clear," the White Paper added, "that in the absence of conscious effort most scientific and technological activities . . . will remain largely oriented toward the United States." The sheer volume of the exchange and the strength of the tie was worrisome on another count. The government acknowledged areas of activity "that can no longer be performed efficiently except on a scale that exceeds national dimensions." Policymakers also understood "a whole host of linkages that lend cumulative substance to the reality of interdependence . . . a global trend from which Canada can neither claim nor expect to be exempt." Nevertheless, the linkages between Canada and the United States "are probably more numerous and more pervasive than between any other two countries and the affinities between them are also such as to put particular strains on the definition of the Canadian identity." To preserve that "distinct" identity and Canadian independence, Canada would exercise the Third Option – a comprehensive, long-term strategy "to develop and strengthen the economy and other aspects of its national life and in the process to reduce the present Canadian vulnerability." Standing in contrast to the first option – maintenance of the status quo – and second option – closer integration with the United States – the Third Option "assumes that the continental tide can be stemmed to some extent."

> "If the outcome is a Canada more confident in its identity, stronger in its capacity to satisfy the aspirations of Canadians and better equipped to play its part in the world, it is an outcome that . . . should buttress the continuation of a harmonious relationship between the two countries"[52]

The exercise of the Third Option would entail the "mutually-reinforcing use of various policy instruments," including science policy and industrial

policy. It would bring into play the concept of counterbalancing, offsetting forces. While "there is clearly no possibility of our being able to surmount overnight Canada's heavy dependence on the United States for trade, investment and technology . . . there is no reason why we should not aim . . . to achieve relative shifts . . ."[53] Or, as the White Paper had noted in a similar reference:

> "It is not realistic to image that the present trends could be changed 90 degrees in direction, even if it were deemed desirable to make the attempt, but there would be much merit in seeking to develop at least some measure of countervailing influence."[54]

As one means of pursuing such countervailing influence, Canada sought to diversify and hence to expand its international science and technology relationships. The dispatching of a 46-person scientific and technical mission to Japan, the conclusion of a Type I umbrella with the Federal Republic of Germany, and the eventual signing of a Type II framework agreement with the European Communities are outstanding examples discussed in the following section. The inventory of cooperation detailed earlier reveals how the Third Option was also generally employed as an additional, supporting rationale for the strengthening of scientific relations with all advanced countries, including Belgium and even the Soviet Union. An assessment of the impact on relations with the United States, however, indicates that in terms of day-to-day contact at the working level – the type of exchange that forms the bulk of the scientific and technical relationship – the Third Option has resulted in little, if any, change. On the other hand, the case study of the space shuttle agreement suggests that the Third Option may have had some negative effects on the implementation of large programs requiring decision at senior policy-making levels.

Certainly, the Americans seemed to see a problem. In December 1975, the then US Ambassador William Porter told the Canadian press that relations between the two countries had "deteriorated" over his two-year term of office. One sign, he said, "was the diminished cooperation between the two countries in the field of scientific research, including nuclear research." The days when the Canadian and American scientific communities "dealt with each other in a spirit of complete cooperation had passed" and, in the ambassador's opinion, "Canada was the loser."[55] Six months later, Porter's similarly outspoken successor, Thomas Enders, made related comments in an Alberta speech on energy research and development. During and after World War II, Enders declared, "Canada and the United States had an intensive program of joint R & D, mainly nuclear. CANDU is one of the products. However, in recent years cooperation has been on a sharp downward trend. Joint projects are now quite insubstantial . . . ."[56]

These statements suggested some American concern over application of the Third Option. There would seem to be no cause for alarm so long as diversification was meant to "supplement" rather than "supplant" science and technology relations with the United States.[57] The Americans seemed worried, however, that the Canadian government's restraint program, which included funding cuts affecting nuclear and non-nuclear energy research as well as other important sectors, in combination with the Third Option would have the net effect of substantially reducing the level of cooperation. To date, this does not seem to have occurred, perhaps because policy makers have found the diversification of science and technology relations to be a more

arduous task than the diversification of cultural or even trade relations. It has been complicated not only by the economic realities of the north-south axis, and the presence of the United States as a world centre of excellence, but by the long history of a well-nurtured, all-pervasive science and technology relationship, a relationship quite unmatched by that of any other two countries. The Third Option, according to current analysis, now "appears largely forgotten, along with the circumstances that gave it birth." The 1976 elections in the United States and especially the election in Quebec dealt critical blows to a policy already growing "moribund." Separatism seems "in the short run at least . . . a greater threat to Canadian survival than dependence on the United States."[58] Yet in the development of significant new scientific and technological associations with other advanced nations, a Third Option legacy lives on.

The OECD Countries

On 21 October 1976, Pierre Trudeau and his Japanese counterpart, former Prime Minister Takeo Miki, signed a bilateral Framework Agreement for Economic Cooperation. At his Tokyo press conference the following day, the Canadian prime minister described the agreement as "the final piece in the balancing act we tried to establish to implement the third option, to make sure that we were diversifying our economic relations towards Europe on the one hand, towards Japan on the other."[59] In the effort to create a counterweight to the influence of the United States, the European Community and Japan functioned as the two "main centres of gravity."[60] The non-American, non-Commonwealth members of the Organization for Economic Cooperation and Development (OECD), in sharing with Canada highly industrialized market economies and common political and security interests, represented the logical primary focus of the new diversification strategy. And each major "piece in the balancing act" encompassed, in varying degree, some form of an enhanced relationship in science and technology.

The Canada-Japan Framework Agreement

Canadian interest in developing scientific-technical cooperation with Japan predated enunciation of the Third Option. Scientists at the National Research Council had begun to contemplate the idea of a working-level exchange program in the mid-1960s. Japan's spectacular post-World War II development and quick rise to the stature of one of the world's most technologically advanced nations suggested an attractive potential. From a political and commercial standpoint, the idea merited strong support. Japan had become Canada's third largest trading partner and an increasingly important source of foreign investment. The growth of shared concerns and complementary interests, of new interactions, and of economic interdependence suggested that "the development of ever closer relations with this dynamic power must be regarded as a first priority for Canadian attention . . . ."[61] The negotiation of a scientific exchange agreement offered one way of strengthening the relationship, and this possibility was informally raised in April 1969 at the fifth meeting of the Canada-Japan Ministerial Committee.

By the time of the sixth meeting, two and a half years later, no agreement had yet evolved. The Japanese had seemed enthusiastic, initially, but had pleaded budgetary restraint and bureaucratic complexities as reasons for leaving the matter in temporary abeyance. Some Canadian policy makers

suspected that Japanese caution might be more closely related to another concern: a worry over the number of countries seeking access, via the development of formal ties with Japan's science and technology community, to the Japanese "magic formula" to the secret of industrial success. In any case, Canadian officials did not press the idea. The setting-up of the Ministry of State for Science and Technology, with attendant shifts in the policy structure, delayed the planning of further initiatives. Canadian and Japanese nuclear agencies signed an agreement in September 1971 providing for exchanges in the field of heavy-water technology. Otherwise, the two countries agreed only that Canada would send a mission to discuss "ways and means of enhancing scientific and technological cooperation between the two nations."[62]

That mission left for Japan in March 1972. Led by Alastair Gillespie, then Minister of State for Science and Technology, the delegation was made up of 40 representatives from senior levels of the federal and provincial governments, universities, and industries, and six members of a coordinating and support staff. The mission was organized by sector, with each sector team responsible for exchanging information and pinpointing collaborative potential in such fields as urban development, health sciences, fisheries, agriculture, transportation, oceanography, environmental policy, and information science. In the joint communiqué issued at the conclusion of the week-long visit, the two countries agreed to continue an "exchange of information" in some of these areas, and to hold "additional discussions . . . at an early date to identify possible joint endeavours" in other sectors. Officials also hoped "to meet regularly to coordinate and promote bilateral cooperation in science and technology and its industrial application," with the first such gathering to take place in Canada the following year. On the lingering question of an intergovernmental science and technology agreement, "talks are proceeding . . . in exploration of some formal arrangement which will provide a general framework for future cooperation." In the interim, "Japan and Canada will initiate appropriate actions to follow-up the discussions held during the mission's visit."[63]

Providing adequate follow-up to the Gillespie mission proved difficult. As the lead department, MOSST had assumed the responsibility for the Canadian side, but the agency found it hard to cope with the extensive range of new undertakings that had resulted from various initiatives. In the fall of 1972, for example, the ministry was busy writing up a report on the first Canada-Belgium Mixed Commission meeting, organizing a similar meeting under the terms of the agreement with Germany, and preparing for the arrival of a scientific delegation from the People's Republic of China. Hence MOSST took almost a year and a half to produce a report on the Gillespie mission and preparations for a reciprocal visit from the Japanese were delayed. Much of the momentum dissipated. Despite the unwieldy size of the Canadian delegation, Japanese officials had been favourably impressed by its competence and vitality. With lack of follow-up, however, the attraction diminished. Other interested policy makers grew worried. As a Senate Committee had pointed out, Japan offered "exciting scope for new cooperation in the scientific and technological fields," and the Gillespie mission had represented "the beginning of an important new stage in this process . . . ."[64] "Broadening and deepening both the quality and quantity of exchanges" wrote one official in External Affairs, "is essential to Canadian interests."[65]

The number, position, and rank of participants in the Japanese return mission, which was finally hosted by MOSST in November 1973, suggested some cause for Canadian concern. The delegation of six Japanese bureaucrats, possessing little scientific expertise, posed a striking contrast to the high-powered 46-member Gillespie mission, with its large component of specialists. This limited response to the Canadian initiative seemed merely obligatory in nature, and appeared to indicate a lack of any real Japanese interest in the sort of broadly based intergovernmental exchange originally envisioned. As a consequence, the idea of a Type I agreement was abandoned, although the possibility of a Type IV exchange remained open for negotiation with the National Research Council.[66] In any event, the burdensome nature of obligations assumed under existing umbrellas had led policy makers to question the advantages of the Type I form of cooperation. By 1973, they had begun to regard the exchange of missions not only as a necessary preparation for signing an intergovernmental agreement, but also as a means in itself: a perhaps simpler and more cost-effective way of strengthening bilateral relations in science and technology. When carried out in a regular fashion and on a manageable scale, and when geared toward a few sectors of mutual interest, a mission, rather better than a formal accord, might be able to generate real collaboration. Successful adoption of the informal technique seemed dependent, however, upon a high degree of intragovernmental coordination. Without the structure of a formal agreement, activity tends to be diffused and without an adequate coordinating and monitoring mechanism, overall reciprocity can be hard to attain.

Some Canadian officials lamented an absence of reciprocity in exchanges with Japan, and the fragmentation of the government's science and technology community did appear to make it easier for the Japanese to secure the greater benefit. In pursuing a sectoral approach, Japan took advantage of the fact that the Canadian federal bureaucracy had no centralized system for gathering and exchanging information on overlapping, informal, science-based international activities. For example, scientists suspected that the highly organized Japanese, who lagged behind North Americans in most areas of space research, had gained a great deal through several unreciprocated visits to government space laboratories: each separately sponsored for individual departmental reasons by Industry, Trade and Commerce, National Research Council, Communications, and the Canada Centre for Remote Sensing.

External Affairs, in taking over the lead role from MOSST in 1974, tried to cultivate a more coordinated approach, to insist on better reciprocity, and especially to move beyond the exchange of missions to realize some genuine collaboration with Japan. But the task remained difficult. The relationship still seemed to evoke more rhetoric than substance. In September 1974, on the occasion of Prime Minister Tanaka's visit to Ottawa, Japan and Canada reiterated the commitment to "constant efforts" on behalf of enhanced cooperation, and "emphasized the scope for further exchanges."[67] Yet out of 72 possible areas for cooperation already suggested by the Gillespie delegation, and out of all the other topics identified in subsequent consultations, only one collaborative project ever emerged. In April 1974, Canada's Transportation Development Agency signed a Memorandum of Understanding with the Japanese Ports and Harbours Research Institute for joint cooperation in research on offshore structures.

The offshore structures project was developed on the initiative of the

Swan Wooster Engineering Company of Vancouver. A Swan Wooster representative had gone along on the Gillespie mission, and had noted Japanese interest in the design, construction, and operation of berthing structures for very large carriers in exposed deep-water locations. Canadian engineers had designed such mooring and loading facilities for ships in Canada and overseas, and Japanese engineers apparently had a special expertise in model testing. It was an instance, in theory at least, of complementary know-how that could be combined to the technological and perhaps commercial advantage of both countries. In reality the project was formally terminated upon completion of a preliminary exchange-of-information phase. Guided by a joint steering committee made up of representatives from interested government agencies and the private sector, the project had moved slowly from the beginning. Perhaps Canadian expectations were too high. As the only concrete venture to result from the exchange of scientific missions, officials may have pinned too many hopes on its successful conclusion. In any case, Canadians thought they perceived a less than complete commitment on the part of the Japanese, and complained of less than equitable return. The absence of full reciprocity appears to have been the primary reason for closing out the agreement in 1977, and for not moving on to a more advanced stage. The offshore structures project did, however, promote personal contacts that enabled a continuity interchange on an *ad hoc* basis. Canada and Japan are now exchanging engineers, one per year each way.

Difficulties encountered in the implementation of scientific-technical exchanges with the Japanese were also related to profound cultural differences between the two countries. The development of "cultural understanding," wrote one policymaker, or at least of "cultural respect," would take time and an ongoing effort to mature and expand business, tourist, and academic in addition to scientific connections.[68] In the view of the prime minister's chief foreign policy adviser, it was in the Japanese, as well as in the Canadian interest, to continue encouraging the necessary ties and contacts:

> "[Canada's] attractions are almost self-evident: an opportunity for Japan to forge links with North American technology . . . industrial concepts and . . . manufactured goods without increasing Japanese dependence on the United States . . . . The imaginative application of Canadian assets such as space, energy and unique technology could be instrumental in the solution of many of Japan's current problems."[69]

As for Canada, it is the object of the government to continue fostering "a deeper and more intimate relationship than the one now existing."

In working toward that end – fulfillment of the Third Option – officials tried to spur not only public sector but also private sector technological exchange. An attempt to overcome the gross imbalance of raw over processed materials in exports to Japan included the promotion of industrial cooperation. Although Canadian trade ministers had "lobbied assiduously" to sell Canadian manufactures, especially high-technology goods like STOL aircraft, CANDU reactors, and pollution-abatement equipment, the trade continued to reflect "exactly what Japan most needs . . . and what it most wishes to sell."[70] In 1974, the year after Japan had displaced Britain to become Canada's second largest trading partner, only 2.8 per cent of all Canadian exports to the Japanese fell in the category of finished goods. By 1976, that figure had slipped to 2.4 per cent. Indeed, Canada's overall record in the 1970s was a "deteriorating one." Canada was Japan's sixth most important

supplier of machinery and manufactured products in 1970, but in 1975 Canada was thirteenth, "outstripped by Australia, the Soviet Union and even South Africa."[71]

The Framework Agreement for Economic Cooperation signed by Prime Ministers Trudeau and Miki in October 1976 was a key expression of the government's desire to remedy the situation. In 1975, the then External Affairs Minister MacEachen had promised an upcoming "multi-phased exploration of potential areas of bilateral economic and industrial cooperation" which could offer "enormous" benefits to both countries. MacEachen emphasized that while "governments would of necessity initiate, stimulate and facilitate" the cooperative process, success would depend upon the active participation of the private sector. "Industrial cooperation would be fruitless if it remained an abstraction: it must lead to bilateral investments, exchanges of technology and inter-corporate relationships – particularly joint ventures – between Japan and Canada."[72] In a similar vein, the prime minister explained the framework accord as a document that "is opening roads to the private sector . . . or to the public sector as in the case of CANDU."

> "We're just asking that the Japanese . . . understand that Canada is a modern technological nation . . . and this being written in the framework agreement, we are convinced that the direction of business will change . . . . But it is up to the private sector to make sure that this . . . partnership of immense value is also of value to them and not only to the Japanese."[73]

The Japanese accord was modelled on the framework agreement concluded with the European Communities three months earlier. The Euro-Canadian agreement was a more formal understanding requiring publication in the Canada Treaty Series, but while the formats differed somewhat, the intent was basically the same. Both agreements were major completing pieces in the policy plan designed to carry out the Third Option. Both were geared to trade development, to the strengthening of commercial ties. Both set up a joint committee, which would meet once a year to review ongoing activities and promote further cooperation. And both agreements sought, in addition, to encourage interfirm technological exchange, joint ventures, or other forms of industrial collaboration. The first meeting of the Canada-Japan Joint Committee was held in Vancouver in June 1977, and follow-up to the discussions included exchanges in the energy sector and in pulp and paper technology. A second meeting is being planned for Tokyo in the spring or summer of 1979.

While it is too soon to offer an evaluation of the Japanese accord, officials discern some hopeful signs. Close economic cooperation at the governmental level does appear to have spurred a closer association at the business level. In the formation of the Canada-Japan Business Cooperation Committee, the private sector has, for the first time, a permanent forum for joint consultation. The Cooperation Committee's May 1978 meeting in Tokyo, and Japan's $75-million investment in tar sands development, are two recent events that may reflect the spirit of the framework agreement. In evolving mutually advantageous technological relations, perhaps the private sector will enjoy more success than the public. Yet given Japan's considerable political and economic importance, it seems apparent that the government will go on trying to realize some of the seemingly rich potential in its scientific association with Japan. For in some respects, an assessment is premature. The science and technology relationship is less than a decade old. The two most

significant agreements, the NRC and framework accords, are too recent to be judged. With more time and experience of each other, and through a broader range of contacts, cultural barriers may become less significant. In light of Japan's particular penchant for absorption of foreign knowledge, the most awkward problem to date – the absence of full reciprocity – might seem beyond solution. The task would be eased, however, by a concerted effort to meet the level of Japanese organization with improved interdepartmental monitoring and coordinating procedures.

The Umbrella with the Federal Republic of Germany

Canada signed a Type I science and technology agreement with the Federal Republic of Germany on 16 April 1971, less than a week before signing a similar umbrella with Belgium. Scientific relations with Germany were already well-established. Multilateral cooperation took place in the OECD, NATO's Committee on the Challenges of Modern Society, and other international organizations. Since 1949, NRC had awarded over 100 post-doctoral fellowships to Germans. NRC also supported many of the numerous visits by Canadian scientists to German universities, and exchanges with various research facilities. Canada had negotiated Type III atomic energy and defence science agreements with Germany, and in 1968 an arrangement providing for German use of the Churchill Research Range was concluded. Indeed, it was during discussions preceding signature of the latter agreement that the possibility of a general accord was first raised.

The suggestion apparently came from a German initiative, but Canadian officials were immediately enthusiastic. West Germany was one of the world's most powerful industrial entities with a political influence to match, particularly in the European Community. After the United States, Britain, and Japan, Germany was also Canada's most important trading partner and a valuable source of foreign investment. The Germans were highly advanced scientifically, and had been interested for some time in broadening the scope of their association with Canada. Most importantly, a science and technology agreement with the Federal Republic was an initial part of the plan to develop a counterweight, to diversify relations, to build a bond with the Community by multiplying the ties with member states. In March 1971, a 25-person science and technology delegation, led by a senior official from Industry, Trade and Commerce, arrived in Germany to examine the potential for expanded cooperation, particularly in the area of industrial R & D. A month later, the umbrella was signed in Bonn during the course of a Canadian trade mission by the then IT&C Minister Jean-Luc Pepin and German Foreign Minister Walter Scheel. The agreement was described as a "declaration" of the mutual wish to "increase the number of substantial activities undertaken jointly . . . in a field both [governments] recognize as constituting an increasingly important dimension of international relations." The umbrella was "designed to foster intensification of cooperation in research and development between the public and private sectors of the two countries." Hence, "substantial benefits . . . for the Canadian scientific and industrial communities" were anticipated, with information sciences, environmental sciences and the construction industry appearing "to hold out particular promise."[74]

Like other Type I framework agreements, the German accord did not live up to expectations. The experience was not as frustrating or disappointing as the experience with Belgium, but some of the same initial mistakes were

made and many similar problems were encountered. For example, at the first two Joint Committee meetings held in Ottawa and Bonn in December 1972 and May 1974 respectively, the delegations were so large that consultation was impeded. Experts on both sides found themselves tied up for three days in plenary sessions that might touch on their areas of concern for a few hours at most. Nine delegates representing six provinces (British Columbia, Alberta, Manitoba, Ontario, Quebec, and Nova Scotia) at the 1974 meeting also generally felt that their interests would be better served in small working groups. The adoption of the latter format at subsequent consultative meetings, together with a reduction in the size of delegations, improved both efficiency and effectiveness, but other difficulties were not as readily eased.

From the beginning, financing posed a dilemma. The German coordinating agency, *Bundesministerium Für Forschung und Technologie* (BMFT), administered a multibillion-dollar budget that appeared to include an adequate central fund for international cooperation. Canadians, on the other hand, could engage in little more than an exchange of reports and papers unless a suggested joint project happened to fall within a category for which funds had already been allocated. Sometimes an initiative could be delayed, and money obtained in the next fiscal year, but the Canadian coordinating agency, which for this agreement has always been MOSST, never had the means to seed a project. This lack led the Germans to observe in 1975 that there had been an "imbalance so far in the programme of visits in favour of German scientists visiting Canada," and to enquire about the possibility of centralized funding "to support Canadian scientists wishing to visit the FRG."[75] Some Ottawa officials privately expressed the view that West Germany also seemed to have a better idea of what it wanted from the agreement than did Canada. Yet both sides repeatedly stressed the importance of moving beyond the exchange-of-information phase of translating the existing level of activity into concrete collaborative ventures. "The goal of cooperation," the 1977 Committee concluded, "must be the execution of projects which, by their cooperative nature and the pooling of resources, either lead to overall savings . . . or produce better results than purely national activities." Efforts should be directed "particularly" toward industrial R & D.[76]

To date, the German agreement has yielded one successful project in the latter category – the joint development of a deep-sea towing system by Fathom Oceanology Limited of Canada and Dornier Systems of Germany. As the 1975 consultative committee noted, "this was an excellent example of bilateral cooperation through which a mutual scientific need led to technical development which in turn led to a commercially viable product."[77] Unfortunately, the Dornier-Fathom example is the *only* example. Officials hold out hope for similar success from a cooperative program, currently in the stage of a feasibility study, being carried out by a German consortium with Spar Aerospace. The companies are looking toward development of a remotely controlled ocean submersible. Otherwise, the Canadian-German agreement has resulted primarily in exchanges of information between experts in government departments, and sometimes also in provincial agencies, industries, and universities, in such fields as transportation technology, health sciences, non-nuclear energy research, geoscience, and data processing. In the environmental sector, federal officials recently described their participation under the umbrella as "very active and useful," with some 30 ongoing "projects . . . ranging from information exchange, through collaboration in

joint studies to exchanges of scientists [in] . . . oceanography, fisheries and marine biology, water pollution control and freshwater research." Indeed the marine science sector is one area of cooperation that proved fruitful and has progressed beyond the mere exchange of data.[78]

Overall, the scientific benefits of these and similar exchanges do not yet balance the costs – the investment in time, money, and manpower. It appears probable, too, that the industrial cooperation undertaken by Fathom Oceanology or Spar Aerospace could have been generated outside the structure of a formal accord. The government has sometimes underestimated the adequacy of existing industrial links. Steel-making technology, for instance, was listed by the 1975 Mixed Committee as a cancelled project because Canadian steel companies were satisfied with the current level of exchange being carried out with German counterparts. Efforts expended are occasionally duplicative in other ways. A topic suggested by a federal or provincial government department might already be the subject of bilateral cooperation in any one of the international agencies to which both Canada and Germany belong. In sum, out of all of Canada's intergovernmental science and technology agreements, officials had anticipated the greatest value from the arrangement with West Germany. The latter accord has fulfilled its promise better than the others, but financial and other administrative problems have been just as perplexing and, as in all cases, the benefits so far are more political than either scientific or economic. As the Canadian ambassador to West Germany recently observed, in the effort to sustain and reinforce the bond with Europe as a whole, Canada continues to attach "the highest priority" to relations with the Federal Republic.[79]

The European Community and the Contractual Link

Late in 1969, Jean-Pierre Goyer, then Parliamentary Secretary to External Affairs Minister Sharp, informed a European audience that to date, "Canada's technological cooperation with Europe has not been significant. No major joint project has been carried out . . . . Canadian scientists, individually or through international organizations, have established personal contacts with their European counterparts . . . . [But] are such exchanges," he asked, "the answer today to the growing importance of science and technology?" Mutually profitable collaboration might henceforth materialize, Goyer suggested, in such sectors as space research, atomic energy, transport and communications, oceanography, and computers.[80] The government's foreign policy White Paper, published six months later, noted most of the same fields plus arctic research, metallurgy, and earth sciences as "additional possibilities for fruitful cooperation . . . ."[81]

Over the next several years, officials worked toward realizing some of this potential through the conclusion of Type I agreements with West Germany and Belgium, Type III agreements with Italy, France, the European Space Research Organization, and European Space Agency, a Type IV agreement with France, and various kinds of less formal cooperation with a number of other countries. Canadian participation in the specialized agencies of the UN and on the scientifically oriented committees of NATO and the OECD also expanded. The science-based departments of the federal government became involved with the European Economic Community on an *ad hoc* basis in sectors like energy policy and environmental cooperation. All of these bilateral and multilateral efforts, together with similar exertions in

other economic and political spheres, culminated in the July 1976 signing of the Type II Framework Agreement for Commercial and Economic Cooperation Between Canada and the European Communities.[82]

The Canada-EC agreement, the so-called "contractual link," is the first treaty of its kind between the Community and a developed nation. From the standpoint of the Common Market, it represents security of access to Canadian resources and raw materials. From Canada's perspective, the agreement is a major articulation of the Third Option. It expressed a convergence of two goals – economic prosperity and political autonomy – held "irreconcilable" in terms of relations with the Americans. The agreement is aimed at diversification. It is a facilitative mechanism whereby Canada may seek "expanded trade and technological cooperation while countering the drift towards economic and cultural domination by the United States." In negotiating the agreement, Canadian officials pointed out the advantages of a Euro-Canadian counterpoise to American power and influence. The potential for technological collaboration was "especially stressed . . . . Alone, any one of them was dwarfed by the United States; together, as advanced industrial societies, they could perhaps escape some of their dependence on American expertise." The development of individual bilateral connections such as those already in effect with Germany, Belgium, and France was not enough by itself. Policy makers pressed for the contractual link, an agreement with the Community as a whole, "because they believed that the world was being divided into regional trade blocs," and feared the consequences with regard to heightened Canadian dependence upon the United States.[83]

Science and technology are central to the implementation of the Euro-Canadian accord. The document declares as one objective "the encouragement of technological and scientific progress," and calls for the facilitation of "broader inter-corporate links . . . especially in the form of joint ventures," and of "technological and scientific exchanges."[84] Although much of the initiative is being left to the private sector, as in the case of the kindred Japanese agreement, activities to date suggest a supportive governmental commitment of more than symbolic significance.[85] External Affairs Minister Donald Jamieson was quoted as saying, at the time of the first Joint Cooperation Committee meeting in December 1976, that "verbal assurances of cooperation in joint ventures and technological transfer must result in action soon if Europe wanted continued access to Canadian raw materials." Canada "must have proof," he insisted, "that the 'contractual link' with Europe means business not just words . . . ."[86]

In search of that proof, Canada and the Community set up working subcommittees in a number of technological sectors – for example, nuclear energy, aerospace, forest products, and peri-informatics (minicomputers, data processing) – with some of these bodies further divided into consultative subgroups within specific fields. Thus a subcommittee in metals and minerals R & D, approved in March 1978 at the second meeting of the Joint Cooperation Committee, encompasses working-level groups that are seeking ways to develop business perceptions and promote industrial exchanges in coal, steel, asbestos, and related technologies. Overall, the activity to date has produced only one joint venture: a 1976 licensing agreement between Bombardier-MLW, Montreal and Grandi Motori Trieste (GMT) of Italy, by which the Canadian firm assumes the exclusive right to manufacture and market in Canada GMT diesel engines. Officials also concede that trade has increased "only modest-

ly" since the framework was signed.[87] Nevertheless, it seems too early to judge the practical effectiveness of either the provisions for trade expansion or for technological cooperation. The agreement has been in force for little more than two years. It may turn out to be as burdensome and non-productive as other umbrella agreements, but for the moment, the framework seems potentially useful. The working groups, with their heavy emphasis on private sector involvement, and the Supervisory Joint Cooperation Committee, composed of senior policy makers, appear as important new consultative mechanisms. These and other recent Euro-Canadian links, one analyst points out, "like the experience of discussion and negotiation over the last few years, have at least raised the level of mutual awareness . . . ."[88]

France and the Accord-Cadre

As part of the effort to consolidate the association between Canada and Western Europe, Prime Minister Trudeau made his first official visit there in October 1974, stopping in both Brussels and Paris. The trip to Paris was, on the one hand, plain recognition of France's importance in the context of Canada's desire for an agreement with the European Community. The trip was also a reflection of Canada's firm commitment to full restoration of relations with the French. In the early 1960s Quebec's turn to France "for help in strengthening the French cultural fact" was an initiative at first supported by Ottawa, but a diplomatic game began that was "taken to extreme lengths" during the administration of President De Gaulle.[89] The resulting strain in Franco-Canadian relations eased somewhat after the 1969 succession of President Pompidou and the 1970 election of an avowedly federalist government in Quebec, but the process of normalization was a very gradual one.

Throughout the time of strain and transition, the survival and further development of the scientific connection assumed enormous political significance. Even in the period from 1967 to 1969, when the Franco-Canadian relationship was at its most "troubled and bitter . . . the Pearson and Trudeau governments deliberately sought to maintain contacts in areas of practical activity: an agreement on cooperation in military research and development was negotiated and the cultural agreement continued to function."[90] The latter, a Type II framework with provision for scientific cooperation, had been signed in November 1965 as a direct response to the Franco-Quebec cultural understanding concluded in February of that year. The federal agreement had been intended originally as a framework to cover both Quebec and Canadian contacts, but as Quebec proceeded to develop its own autonomous links with France, the Canadian *accord-cadre* grew instead into a form of rival exchange. As an initial expression of the new attitude toward the political use and diplomatic value of official, formalized scientific relations, the Franco-Canadian framework agreement served as the model for later umbrellas. Like its successors, however, the *accord-cadre* has produced only limited scientific benefit, while proving to be an administratively burdensome and expensive form of bilateral cooperation.

In the first few years of the umbrella's life, scientific activity was virtually non-existent. External Affairs had not yet established a scientific relations desk, and the lead division was cultural affairs. Federal officials noticed, nevertheless, that science and technology seemed to be playing an increasingly important role in France's contacts with Quebec. To enlarge the content and enhance the scope of Franco-Canadian scientific involvement, therefore,

the National Research Council agreement with the Quai d'Orsay was concluded late in 1969, pursuant to and subsumed under the 1965 general agreement.[91] Also in 1969, at their third meeting under the cultural umbrella, Canada and France created a scientific subcommission. The latter group was to meet and consult separately from the deliberations of the parent body in order to improve and develop further the scientific link. Hence at the sixth meeting of the Cultural Mixed Commission, the scientific subcommission met on 22 and 23 May 1973, prior to the meeting of the Mixed Commission itself on 24 and 25 May, to discuss cooperation within the more than 60 "*thèmes scientifiques*" identified up to that point, especially in the sectors that had been the focus of five recent Canadian missions: the environment, medical research and public health, agriculture, energy, mines and natural resources, and computers and communications.[92]

Some policy makers considered the mechanism of a subcommission to be inadequate, and felt that Canada should consider the possibility of signing a separate Type I science and technology umbrella. This idea, apparently suggested by France some time after Canada's 1971 conclusion of a separate agreement with Belgium, was supported by MOSST but not by External Affairs. The latter agency seemed to view the initiative as another attempt by the recently formed science and technology ministry to establish itself internationally. Officials at External Affairs also tended to regard relations with France, even in the scientific sphere, as too sensitive politically for coordination by another department. They appeared concerned, moreover, that such a radical change in the structure of Canada's formal scientific association with France might invite a negative reaction from Quebec. A bureaucratic, political, and diplomatic compromise was reached in October 1973 when representatives of Canada and France signed an Exchange of Notes elevating the status of the scientific subcommission to the effective level of the Mixed Commission itself. This action, which also fitted in with the Third Option and the approach to the Community, gave new merit and import to scientific cooperation by making it officially, at least, as consequential as cultural exchange.

The change was symbolically significant but had almost no practical effect. External Affairs' scientific relations desk took over from cultural affairs the task of administering the scientific side of the *accord-cadre*, and stronger efforts were made to develop joint projects, particularly in technological fields with commercial potential like satellite research and computer applications. Some individual science-based departments – Agriculture, Communications, and Health and Welfare, for example – were already extensively involved with France in exchanges of information and personnel, but the promotion of industrial cooperation had seemed more appropriate to an economic rather than a cultural agreement. Officials now sought to coordinate more closely with Industry, Trade and Commerce to remedy the neglect. Despite the high priority assigned to relations with France, however, real collaborative substance still seemed difficult to generate.

Two Canada-France space projects are sometimes cited as excellent examples of the possibilities for useful bilateral interaction, but the *accord-cadre* had little to do with sparking either arrangement. The Franco-Canadian decision to construct a large optical telescope on top of an extinct volcano, in collaboration with the University of Hawaii, was as much the result of "historical coincidence" as of a desire for international cooperation.[93] Indeed, initial Canadian enthusiasm for the project was prompted by one Dom-

inion Observatory scientist's individual visit to Paris. Work was continued under the 1971 National Research Council exchange agreement with the *Centre national de la recherche scientifique* and eventually formalized in the tripartite Canada-France-Hawaii Memorandum of Understanding in October 1973. Similarly, the exchange arrangement between the Canada Centre for Remote Sensing and the *Centre national d'études spatiales*, credited as being pursuant to the 1965 general agreement, arose from primarily informal contacts, including those engendered by Canada's cooperative interaction with the European Space Research Organization and its successor, European Space Agency. Space research is, in any case, a sector of vital national concern to France and exchanges with Canada in that field are recognized as being clearly advantageous. Officials have sometimes lamented a lack of French willingness to explore fully the potential for collaboration in other areas where Canada has not yet developed a comparable international reputation for expertise and excellence. (The French attitude may be changing. At the 1976 meeting of the Mixed Commission France offered not a single proposal, but at the most recent gathering in May 1978, France put forward a number of ideas. Some, such as proposals for the technical testing of Hydrofoil and STOL technology, have commercial implications.)

Occasionally, Canadians are made aware that the smooth conduct of the association with France, and the establishment of meaningful ties, seem more important to them than to the French. This perception, be it accurate or not overall, has tended to colour aspects of the science and technology relationship. On the negative side, an apparent imbalance in the commitment to bilateral cooperation, combined with inadequate Canadian coordinating and monitoring mechanisms, may have resulted, at least sporadically, in a like imbalance of benefits. On a more positive note, the overwhelming political significance of continued scientific cooperation with France has eased the financing dilemma, because the Department of External Affairs has been able to set up a special centralized funding arrangement. And while implementation of the French agreement has been basically just as difficult as the implementation of any other framework, many of the scientists and other officials responsible for carrying out the *accord-cadre* have seemed rather more tolerant of its scientific limitations and deficiencies than in the case of other umbrellas.

Cooperation with Other OECD Countries

Canada has Type III defence science and atomic energy agreements in force not only with major scientific partners like Japan, Germany, and France, but also with smaller nations like Denmark, Greece, Finland, Norway, Italy, Spain, Sweden, and Switzerland. In other scientific and technological sectors, bilateral cooperation with countries in the latter group is carried on without benefit of formal agreement. Scientists at Agriculture Canada working on wheat breeding and cereal quality maintain contacts with Italy's Pasta Institute. The NRC post-doctoral fellowship program embraces researchers from many European nations, including Greece, Switzerland, and Denmark. Officials from Environment Canada engage in informal exchanges of information and visits with colleagues in Finland, Norway, and Sweden. EMR's Canada Centre for Remote Sensing has offered occasional assistance and advice to Telespazio, its Italian counterpart. Indeed, most of the science-based agencies – along with IT&C which sponsors missions and seeks collaborative possibili-

ties in various advanced industrial sectors – are involved in different forms of *ad hoc* bilateral exchange with numerous countries in Europe.

A much greater volume of cooperation in science and technology amongst Canada and most non-American, non-Commonwealth members of the OECD takes place in the context of various multilateral involvements. The extent of Canadian participation in a vast network of international organizations totally or partially concerned with scientific or technological matters is a subject lying considerably beyond the scope of this study. A 1973 Science Council Report listed Canadian membership in 17 separate United Nations agencies and in 44 other intergovernmental organizations, yet even this accounting is incomplete.[94] It does not include NATO's Committee on the Challenges of Modern Society, on which Canada has served for almost a decade, or NATO's civilian Science Committee, "a model for how international collaborative science can work."[95] Neither does the Science Council tally encompass the large number of international organizations created since 1971 as a response to the development or enhanced significance of new scientific and technological issues: for example, the International Energy Agency, Commonwealth Youth Program, UN Committee on Science and Technology for Development, the UN Environment Program, the Senior Advisors on Science and Technology, and Senior Advisors on the Environment of the Economic Commission for Europe. Under the aegis of all these and many more organizations, as well as within such OECD forums as the Committee for Scientific and Technological Policy, Canadians collaborate on a substantive level with representatives from the other industrialized nations that comprise the Organization for Economic Cooperation and Development. Some officials, experienced in both the bilateral and multilateral forms of international scientific relations, have advanced a suggestion that appears to merit further study. They submit that in many cases, the multilateral form is the more advantageous, and that Canadian collaboration with the French or the Germans, among others, seems more productive when it takes place within an international organization rather than under an umbrella.

V. Summary and Conclusion

Canadian government participation in international science and technology from the end of World War II through to the mid-1960's seems, in retrospect, an involvement of manageable proportions. Analysis of the period before 1965 reveals only 21 Type III agreements, with activity in that category confined to just three sectors – atomic energy (11), space (6), and defence science (4). Two additional agreements, one Type II (the 1944 cultural arrangement with Brazil), and one Type IV (the 1959 NRC/Soviet Academy Exchange), were also in force. The only government agencies responsible for administration of formal science and technology agreements were the National Research Council, Department of National Defence (or Defence Research Board), Ministry of Transport, and Atomic Energy of Canada Limited. Other departments were involved on an informal basis, but commitments were undertaken solely in accordance with individual departmental needs, interests, and resources. Trade and Commerce engaged in a certain number of export-oriented technical exchange programs with countries like the Soviet Union; the science-based departments carried out cooperative research programs or exchanged information with counterpart agencies in the United States or United Kingdom; and External Affairs supported various technical assistance projects in Commonwealth developing nations. But in all cases, the scope of the activity was limited and could be pursued on a relatively small scale with a minimum of interdepartmental consultation.

The 1965 conclusion of a Type II cultural and scientific agreement with France marked the beginning of a great expansion in Canada's international science and technology relationships. By 1971, Canada had negotiated similar arrangements with other countries, and a new category of agreement had emerged – the Type I general science and technology umbrella. These agreements, requiring the participation of a dozen or more federal government agencies, created a level of involvement so extensive that management and coordination grew difficult. Canadians also began to exchange science and technology missions in this period, and to embark on other kinds of informal bilateral interaction. In little more than a decade, the number of Type III agreements tripled. A new Type IV agreement was concluded on an average of one every 20 months. Seventy per cent of the 81 international science and technology agreements listed in the Appendices were signed between 1965 and 1978. Multilateral relationships also proliferated at a rapid pace as Canadians found themselves increasingly committed to international resolution of globally significant science and technology issues in newly emergent policy areas like space, the oceans, the environment, and energy. The growth of interdependence and accompanying changes in the international system, combined with an expanding perception of science and technology as a valuable national attribute which could be employed abroad in the pursuit of various domestic objectives, led Canada into a complex net of new external responsibilities.

The Agreements

International scientific collaboration has long served as a useful expression of friendship, and its promotion continues to further the integration of the world scientific community. But scientific and technological ends seem better served when cooperation takes place outside the structure of formal bilateral agreements. The least successful form of collaboration appears to be the Type I or II umbrella or framework accord. The two agreements with the Soviet

Union and their counterparts with France, Belgium, Germany, Japan, and the Communities have provided very little, to date, in the way of useful exchanges. The Belgo-Canadian case clearly demonstrates that an agreement cannot, simply by means of its existence, generate scientific or technological cooperation. Strong complementary interests and capabilities are an important precondition. Yet if those interests and capabilities exist, then an umbrella arrangement is usually not required. Canadian collaboration with Germany on development of an undersea system looks at first glance like an excellent example of the sort of joint endeavour that can be generated by an agreement, yet the project could probably have been initiated and carried through quite easily without benefit of an umbrella. Indeed, the cumbersome organizational structure of an agreement can sometimes impede the collaborative process and actually hinder what it was meant to accomplish. The Russian umbrellas and perhaps the framework accord with the Communities may be justified by the fact that they are facilitative, but Type I and II agreements still seem to be an unnecessarily burdensome, inefficient, expensive, and time-consuming form of cooperation.

Type IV general exchange agreements negotiated by the National Research Council with counterpart agencies abroad are a less costly and cumbersome form, but they too appear to engender few scientific or technical advantages. Like a Type I or II umbrella accord, a Type IV agreement is sometimes facilitative, and often diplomatically significant, but benefits for Canadian scientists seem difficult to generate. Reciprocity in terms of quality of personnel and facilities is not always attained, and exchanges of information with countries like Brazil, Czechoslovakia, or the Soviet Union tend to be one-sided. The political results may be commensurate with the investment in time, money, and effort, but the scientific output has not been great.

The Type III category of international science and technology agreement is the only category that offers strong potential for exchanges of real scientific or technological value. This category, encompassing all 27 Canadian-American agreements and 36 bilateral agreements with 24 countries and the European Community, is too large for generalization. Some agreements are productive; others are not. Many agreements have benefited Canada; others seem open to question. For instance, the atomic energy arrangements with developing countries like India or Pakistan were obviously intended for the scientific-technical benefit of the non-Canadian partner, but which partner has derived the greater advantage in the atomic energy agreements with Japan, Italy, or Germany? Similarly, has Canada gained a fair exchange in the defence science agreements with Denmark and Norway, the medical science program with China, or the Hawaii telescope project with France? A complete assessment would seem to require case studies within each science or technology sector, studies that lie outside the scope of this publication. Nevertheless, analysis of the different types of agreement clearly reveals that a Type III arrangement in any sector stands a better chance of success than agreements in other categories. Type I, II, and IV agreements are all oriented toward various forms of *general* cooperation. A Type III agreement is more likely to yield results simply because it is directed toward achievement in a specific field or work on a particular project.

Whether a Type III agreement assumes the form of an interagency Memorandum of Understanding or an intergovernmental Exchange of Letters, the probability of success is greatly enhanced if a history of science and technol-

ogy cooperation already exists. If two countries have previously engaged in some form of productive scientific interaction, they will have better understanding of each other's capabilities and limitations. Cultural barriers, where these are important, will have been mitigated and channels of communication established. Some of the implementing mechanisms will already be in place. The Belgian case demonstrates that a protracted period of informal visit and exchange, of getting acquainted, should generally precede the signature of a formal agreement. The mission technique, first employed in the initiation of science and technology relations with Japan and China, offers one means of demonstrating high-level interest in another country while avoiding an inflexible commitment. Indeed, difficulties encountered in the implementation of existing agreements, together with diminishing government resources, soon made the exchange of missions, or the even simpler *ad hoc* exchange of individuals and information, the preferred method for investigating new areas of potential science and technology cooperation. If reciprocal needs, mutual concerns, or complementary capabilities lead to a joint project, and policy, legal, or financial complexities arise, then a formal agreement can be signed. Many of the Type III agreements listed in the Appendices, including those negotiated with the United States, evolved in this fashion.

Canadian government experience to date strongly suggests that scientific or technological benefits are best attained when bilateral activities are initiated through informal channels. Formal agreements should be contemplated only after a joint venture takes shape, when domestic or foreign policy considerations, financial obligations, or the intricacies of international law demand it. A formal accord may also be demanded by the political requirements of the other country, but in all instances, an agreement for general cooperation should be avoided. The implementing mechanism should be kept as simple as possible, and activities should be pursued in a few, very carefully defined, preselected areas. Canada's existing, unproductive agreements could probably not be abrogated without serious diplomatic repercussions. Most of the agreements are, in any case, of some political significance. Nevertheless, when they come up for renewal, officials should try to reduce the burden they impose by injecting some flexibility into the proceedings, and revising arrangements in ways that will encourage more direct interaction between individuals or agencies, leading to better scientific or technological results.

Political vs. Technological Sovereignty

As the inventory of cooperation shows, Canadians signed science and technology agreements in anticipation of more than scientific or technological benefits. Like the United States, the United Kingdom, France, West Germany, and other advanced countries, Canada viewed the development of international science and technology relations as a useful mechanism for achieving various economic or political objectives. In initiating exchanges with each other, and especially with countries in Eastern Europe, Asia, and Latin America, the industrialized nations sought to expand trade and secure entry to new markets, to strengthen relations with particular governments, and to enhance their images abroad. In many cases, significant political benefits have accrued. By encouraging the growth of scientific and industrial links with the Soviet Bloc, the nations of the West contributed to the normalization of relations and fostered detente. By trading on its scientific and technical knowledge, Canada, followed by the United States and others, helped open the door to

China. By engaging in cooperative science and technology programs with poorer countries, the advanced nations carried out part of their international political commitment to the developing world. The anticipated economic gains, however, have generally been slow to materialize. In most instances, science and technology agreements have done little to penetrate markets or stimulate trade. In Canada's case, certainly, the commercial and economic benefits have been minimal. It may be too early to judge the Type II economic agreements with the European Community (1976), Japan (1976), and Brazil (1977), but earlier Type I and II framework accords appear to have produced few, if any, trade benefits. Some less formal arrangements seem no more advantageous. For instance, officials worked hard in industrial and scientific exchange programs with China to portray Canada as a technologically sophisticated exporter of manufactured goods, yet over the last two years for which figures are available, the volume of trade has decreased.

Other industrialized nations, in sharing with Canada some of the same motivations for participation in international science and technology, encountered similar disappointments and problems. Even the United States, with all its resources, began to feel overextended and to suggest, in the Congressional study cited earlier, that agreements for cooperation in science and technology might be more disadvantageous than profitable. The sudden multiplication of intergovernmental activities and of multilateral commitments within various international forums posed an unaccustomed burden on all advanced countries. The merging of science policy with foreign policy and its accelerated diffusion across traditional departmental lines taxed organizational structures everywhere, and generally created policy confusion. An ever-deepening involvement in science and technology exchange was obviously not an exclusively Canadian phenomenon. All industrialized countries were compelled to cope with the strains and meet the new obligations it imposed. In some respects, nevertheless, the Canadian experience was unique.

The six policy objectives set out in the Trudeau government's 1970 White Paper on foreign relations – peace and security, sovereignty and independence, social justice, economic growth, an enhanced quality of life, and a harmonious natural environment – are probably shared in a general way by a number of countries. Many nations, without publicly or even consciously articulating a similar policy, have linked the development of international relations, including relations in science and technology, with achieving some or all of these goals. Yet in their definition of these national objectives, and in their insistence on a closer harmony between the domestic and foreign applications of policy, Canadians were perhaps exceptional. The Canadian interpretation of, and emphasis on, the sovereignty theme was also atypical, for it encompassed two very special Canadian concerns – the influence of the United States and the impact of the "quiet revolution". The complexity of "living distinct from, but in harmony with, the world's most powerful and dynamic nation," and the "multifaceted problem of maintaining national unity," were described by the White Paper as the "two inescapable realities, both crucial to Canada's continuing existence." If the country was "to thrive as an independent state," officials would have to take note of the "special requirement" brought on by Canada's "particular situation." This requirement would be satisfied, in large measure, by development of relations with countries other than the United States, and by maintenance of Canada's "distinct identity, including particularities of language, culture, custom and

institution."[1] The inventory of international cooperation in science and technology described in this study delineates the ways in which the Trudeau government employed Canadian knowledge and expertise abroad as a means of furthering these interests.

The two case studies, however, illustrate most clearly the effects of the government's foreign policy framework on the conduct of Canada's international science and technology relations. The White Paper noted that most policy decisions involve "hard choices which require that a careful balance be struck" in evaluating various interests and advantages. "Trade-offs" are sometimes inevitable.[2] Analysis of the decision-making process leading to the general agreement with Belgium and the space shuttle agreement with the United States suggests an underlying policy conflict of deeper significance. In retrospect, it appears that officials were being asked to make a choice, in essence, between political and technological sovereignty. In 1975, the Science Council declared the need for "a technological sovereignty consistent with international interdependence." To replace "technological imbalance," Canadians

> "must develop an appropriate amount of original technology, "high as well as "low" . . . and apply it vigorously. We need to stimulate innovation in secondary manufacturing industry. We must add shrewd international collaboration . . . and recognize also that public purchasing policies could be a powerful tool for promoting domestic technological development."[3]

The Belgian agreement is obviously not an example of "shrewd international collaboration" directed toward achievement of Canadian technological sovereignty. On the contrary, the Belgian agreement was directed toward Quebec and the preservation of one aspect of Canadian political sovereignty. Officials hoped it would add to industrial development, but knew when they signed the accord that Belgium would have less to offer than most other European countries. The space shuttle agreement, on the other hand, appeared to fulfill all the requirements for attainment of technological sovereignty in a high-technology field of vital importance to Canada. Yet the decision was long delayed, in part because of the concern with another aspect of political sovereignty – the need to develop at least some measure of countervailing influence to the American orientation.

The attainment of technological sovereignty should not be incompatible with the attainment of political sovereignty. Indeed, the two concepts are complementary. The conflict to date has been rooted not in their mutual exclusiveness, but in confusion among policy makers. The period of most rapid expansion in Canada's international science and technology relations – of formal agreements with Belgium, Germany, and the Soviet Union, of missions to China and Japan, of new interactions through numerous other bilateral and multilateral channels – coincided both with experimental alterations in the science policy structure, and with firm new directions in the organization of foreign policy. In spite of a widespread recognition of Canada's need "to frame and implement a coherent science policy,"[4] domestic scientific and technological requirements were less clearly articulated than external objectives. In those areas where the two concerns merged, consequently, foreign policy goals tended to predominate.

Over the last few years, the demands of science policy and foreign policy have been combined and organized with greater effectiveness, yet serious

difficulties remain. There is nothing wrong with the idea of engaging in international science and technology for internal political or economic reasons. If an involvement develops from this kind of motivation, however, then it should be supported as a diplomatic rather than scientific exchange. The science-based agencies should not be asked to fund such activity at the expense of their own priorities. When ICISTR, the Interdepartmental Committee on International Science and Technology Relations, was created in 1975 intragovernmental coordination improved, but the Comittee's role has become more reactive than developmental. Continuity is still lacking and recent internal changes now also cast doubt on the competence and hence credibility of the lead department. A monitoring system is still needed. Decision making is too diffused. International science and technology is conducted in the absence of any real organizational centre, and questions of policy always devolve on this lack of a focal point for the formulation of an integrated Canadian approach. Officials will have to resolve this problem if they hope to direct Canada's ever-expanding participation in international science and technology toward achievement of either political or technological sovereignty.

Appendices

APPENDIX A

Bilateral Science and Technology Agreements with Countries other than the United States

Each agreement is listed alphabetically by country, beginning with Argentina and ending with Yugoslavia. The list includes one trilateral – the Canada/France/Hawaii Memorandum of Understanding. The agreements have been classified according to four basic types:

I General agreements for cooperation in science and/or technology

II Economic or cultural agreements that include provision for cooperation in science and technology

III Agreements in specific scientific or technological fields or covering particular projects

IV General exchange or cooperation agreements between specified science agencies

Type III agreements are further classified by their science or technology sector. No entry in the "Responsible and/or Signatory Agencies" column indicates that the agreement is intergovernmental rather than interagency in nature, and/or that no particular department was specified as responsible for its implementation. If an agreement has no Canada Treaty Series number, it is either not intergovernmental in status or, in a very few cases, too recent to have been published. Agreements with developing countries pertaining solely to technical assistance are excluded.

Country or Supranational Entity	Type	Type III Science or Technology Sector	Responsible and/or Signatory Agency	Title and/or Description	Date	Canada Treaty Series Reference No.
Argentina	III	Atomic Energy	AECL/CNEA	Exchange of Notes Between the Government of Canada and the Government of Argentina Constituting An Agreement Concerning Nuclear Cooperation	20 December 1973 10 September 1974 In force 12 September 1974	1974/33
Argentina	III	Atomic Energy		Agreement Between the Government of Canada and the Government of the Argentine Republic for Cooperation in the Development and Application of Atomic Energy for Peaceful Purposes	Signed and in force 30 January 1976	1976/12
Australia	III	Atomic Energy		Agreement Between the Government of Canada and the Government of the Commonwealth of Australia for Cooperation in the Peaceful Uses of Atomic Energy	4 August 1959 In force 7 October 1959	1959/18
Australia	III	Space	NRC/ Department of Defence	Agreement Between the Government of Canada and the Government of Australia concerning the use of the Woomera range for launching a Canadian sounding rocket for scientific investigations	1975	
Belgium	II			Cultural Agreement Between the Government of Canada and the Government of the Kingdom of Belgium. Article VI, which refers to the expansion of "cooperation in the field of scientific research as well as in the training of administrative and technical personnel," was supplanted by the 1971 agreement.	Signed 8 May 1967 In force 5 March 1968	1968/3
Belgium	I			Agreement Between the Government of Canada and the Government of the Kingdom of Belgium on Scientific, Industrial and Technological Cooperation	Signed and in force 21 April 1971 Renewed 1976	1971/3

Country or Supranational Entity	Type	Type III Science or Technology Sector	Responsible and/or Signatory Agency	Title and/or Description	Date	Canada Treaty Series Reference No.
Brazil	II			Exchange of Notes between Canada and Brazil Constituting an Agreement for the Promotion of Cultural Relations between the Two Countries. Refers to the encouragement and facilitation of the exchange of the "scientific and technical publications."	Signed and in force 24 May 1944	1944/15
Brazil	IV		NRC/CNPq	Exchange of Scientists Agreement Between the National Research Council of Canada and the Conselho Nacional de Pesquisas	29 August 1968 Funded by CIDA from 12 July 1973 to July 1978	1968/12
Brazil	II			Memoranda of Understanding establishing programs of bilateral cooperation in a number of scientific and technological fields, and creating a mechanism for tripartite cooperation with developing countries	January 1977	
China	III	Medical Science/ Public Health		Agreement on Cooperation in Medical Science and Health Care between Canada and the People's Republic of China	October 1973	
Czechoslovakia	IV		NRC/SVUM	Agreement on the Exchange of Scientists Between The National Research Council of Canada and The Academy of Sciences of Czechoslovakia	24 June 1969 Renewed 1973	
Denmark	III	Defence Science		Exchange of Notes concerning the exchange of defence science information	30 May and 25 July 1968	1968/17
European Atomic Energy Community	III	Atomic Energy	AECL/ EURATOM	Agreement Between the Government of Canada and the European Atomic Energy Community For Cooperation in the Peaceful Uses of Atomic Energy	Signed 6 October and 18 November 1959 In force 18 November 1959	1959/22

Country or Supranational Entity	Type	Type III Science or Technology Sector	Responsible and/or Signatory Agency	Title and/or Description	Date	Canada Treaty Series Reference No.
European Communities	II			Framework Agreement For Commercial and Economic Cooperation Between Canada and the European Communities	Signed 6 July 1976 In force 1 October 1976	1976/35
European Space Research Organization	III	Space	DOC/ESRO	Exchange of Notes Between the Government of Canada and the European Space Research Organization concerning cooperation on advanced space technology (with Memorandum of Understanding)	Signed and in force 18 May 1972	1972/19
European Space Agency	III	Space	CCRS/ESA	Memorandum of Understanding Between the Canada Centre for Remote Sensing and the European Space Agency on Cooperation in Remote Sensing	1976	
Finland	III	Atomic Energy		Agreement Between the Government of Canada and the Government of the Republic of Finland concerning the uses of nuclear material, equipment, facilities and information transferred between Canada and Finland	Signed 5 March 1976 In force 15 August 1976	1976/27
France	III	Defence Science		Exchange of Notes Between the Government of Canada and the Government of France concerning the exchange of defence science information	Signed and in force 25 May 1962	1962/7
France	II			Cultural Agreement Between the Government of Canada and the Government of the French Republic	Signed and in force 17 November 1965 Scientific Relations Section modified by Exchange of Notes, 23 October 1973	1965/21
France	III	Atomic Energy	AECL/CEA	Agreement Between Atomic Energy of Canada Limited and the Commissariat l'energie atomique for the exchange of information in the field of heavy water reactors	15 October 1968	

Country or Supranational Entity	Type	Type III Science or Technology Sector	Responsible and/or Signatory Agency	Title and/or Description	Date	Canada Treaty Series Reference No.
France	IV		NRC/Quai d'Orsay	Exchange Agreement Between the National Research Council of Canada and the Government of the French Republic	19 November 1969	Pursuant to 1965/21
France	IV		NRC/CNRS	Agreement on Scientific Cooperation Between the National Research Council of Canada and the Centre national de la recherche scientifique	March 1971	
France	III	Space	NRC/CNRS/ University of Hawaii	Memorandum of Understanding among the Centre national de la recherche scientifique of France, the National Research of Canada and the University of Hawaii concerning the installation and operation of a large optical telescope on Mauna Kea, Hawaii	25 October 1973 Revised February 1976	Tripartite, inter-governmental agreement pending
France	III	Space	CCRS/CNES	Arrangement between the Canada Centre for Remote Sensing and the Centre national d'études spatiales establishing scientific and technical cooperation programs in fields of airborne and satellite systems, data processing, and applications development.	30 November 1976	
Germany	III	Atomic Energy		Agreement and Exchange of Notes Between the Government of Canada and the Government of the Federal Republic of Germany for Cooperation in the Peaceful Uses of Atomic Energy	Signed 11 and 18 December 1957 In force 18 December 1957	1957/29
Germany	III	Defence Science		Exchange of Notes Between the Government of Canada and the Government of the Federal Republic of Germany concerning the exchange of information relating to defence science	Signed 21 and 28 August 1964 In force 28 September 1964	1964/18

Country or Supranational Entity	Type	Type III Science or Technology Sector	Responsible and/or Signatory Agency	Title and/or Description	Date	Canada Treaty Series Reference No.
Germany	III	Space		Exchange of Notes Between the Government of Canada and the Government of the Federal Republic of Germany Constituting an Agreement Concerning the use of the Churchill research range	Signed and entered into force 15 November 1968 Amended and/or extended by further agreements, 8 July 1969; 28 April 1972; 7 and 29 June 1973 In force 1 July 1973; September 1975	1968/21 1969/13 1972/14 1973/26
Germany	I			Agreement Between the Government of Canada and the Government of the Federal Republic of Germany on Scientific and Technical Cooperation	Signed 16 April 1971 In force 28 June 1971 Renewed June 1976	1971/52
Greece	III	Defence Science		Memorandum of Understanding Between the Government of Canada and the Government of Greece for the Exchange of Information in Defence Science	Signed 17 and 18 July 1962 In force 18 August 1962	1962/12
India	III	Atomic Energy		Agreement Between the Government of Canada and the Government of India relating to the Rajasthan atomic power station and the Douglas Point nuclear generating station	Signed and in force 16 December 1963 Amended 16 December 1966	1963/10 1966/27
Iran	III	Atomic Energy		Agreement Between the Government of Canada and the Imperial Government of Iran for Cooperation in the Peaceful Uses of Atomic Energy	Signed 7 January 1921 In force 10 April 1973	1973/2

Country or Supranational Entity	Type	Type III Science or Technology Sector	Responsible and/or Signatory Agency	Title and/or Description	Date	Canada Treaty Series Reference No.
Italy	III	Atomic Energy	AECL/CNEN and ENEL	Cooperation Agreement Between Atomic Energy of Canada Limited and the Comitato Nazionale di Energia Nucleare and the Ente Nazionale per l'Energia Elettrica	1970 Renewed 1975 for an additional five years	
Japan	III	Atomic Energy		Agreement and Exchange of Notes Between the Government of Canada and the Government of Japan for Cooperation in the Peaceful Uses of Atomic Energy	Signed 2 July 1959 and 27 July 1960 In force 27 July 1960	1960/15
Japan	III	Atomic Energy	AECL/ Japanese Atomic Energy Agency	Agreement on the Exchange of Information Relating to Nuclear Reactors Between Atomic Energy of Canada Limited and the Japanese Atomic Energy Agency	September 1971	
Japan	III	Oceanography/ Transportation	TDA (DOT) Canada/PHRI Japan	Memorandum of Understanding Between the Canadian-Transportation Development Agency and the Japanese Ports and Harbours Research Institute on Joint Cooperation in Research on Offshore Structures	27 April 1974 Terminated 1977	
Japan	IV		NRC/JSPS	Agreement on Scientific Cooperation Between the National Research Council of Canada and the Japan Society for the Promotion of Science	22 May 1975	
Japan	II			Framework Agreement for Economic Cooperation Between the Government of Canada and the Government of Japan	21 October 1976	
Korea	III	Atomic Energy		Agreement Between the Government of Canada and the Government of the Republic of Korea for Cooperation in the Development and Application of Atomic Energy for Peaceful Purposes	Signed and in force 26 January 1976	1976/11

Country or Supranational Entity	Type	Type III Science or Technology Sector	Responsible and/or Signatory Agency	Title and/or Description	Date	Canada Treaty Series Reference No.
Norway	III	Defence Science		Exchange of Notes Between the Governments of Canada and Norway Concerning the Organization of the Canada-Norway Defence Science Information Project	Signed and in force 24 May 1960	1960/11
Pakistan	III	Atomic Energy		Agreement Between the Government of Canada and the Government of Pakistan for Cooperation in the Peaceful Uses of Atomic Energy	Signed 14 May 1959 In force 18 July 1960	1960/14
Pakistan	III	Atomic Energy		Agreement Between the Government of Canada and the Government of Pakistan Relating to the Construction of the Karachi Nuclear Power Station	Signed and in force 24 December 1965	1965/26
Spain	III	Atomic Energy		Agreement Between the Government of Canada and the Government of Spain for Cooperation in the Peaceful Uses of Atomic Energy	Signed 8 September 1964 In force 14 May 1965	1965/7
Sweden	III	Atomic Energy		Agreement Between the Government of Canada and the Government of Sweden for Cooperation in the Peaceful Uses of Atomic Energy	Signed 11 September 1962 In force 6 December 1962	1962/19
Sweden	III	Defence Science		Agreement Between the Government of Canada and the Government of the Kingdom of Sweden Concerning Defence Research, Development and Production	Signed and in force 3 February 1975	1975/2
Switzerland	III	Atomic Energy		Agreement Between the Government of Canada and the Government of the Confederation of Switzerland to Provide for Cooperation in the Peaceful Uses of Atomic Energy	Signed 6 March 1958 In force 31 July 1958 Renewed 26 November 1964 with effect from 31 July 1963 Renewed 23 April 1969 with effect from 31 July 1968 Renewed 1 December 1971 with effect from 1 August 1971	1958/8 1964/25 1969/9 1971/44

Country or Supranational Entity	Type	Type III Science or Technology Sector	Responsible and/or Signatory Agency	Title and/or Description	Date	Canada Treaty Series Reference No.
Taiwan	III	Atomic Energy	AECL/ Atomic Energy Council	Agreement entered into by Atomic Energy of Canada Limited to supply a nuclear research reactor to the Atomic Energy Council of Taiwan	September 1969	
Union of Soviet Socialist Republics	III	Atomic Energy	AECL/State Committee	Agreement for Cooperation in the Peaceful Uses of Atomic Energy between Atomic Energy of Canada Limited, a Canadian Government Agency, and the State Committee of the USSR for the Utilization of Atomic Energy	24 January 1964 Extended by a Protocol 27 May 1968 Renewed for a further five years, 27 May 1973	
Union of Soviet Socialist Republics	III	Metallurgy	EMR/State Committee	Exchange Agreement Between the Mines Branch of Energy, Mines and Resources, a Canadian Government Agency, and the State Committee of the USSR for Science and Technology	June 1965	
Union of Soviet Socialist Republics	I			Agreement Between the Government of Canada and the Government of the Union of Soviet Socialist Republics on Cooperation in the Industrial Application of Science and Technology	Signed and in force 27 January 1971 Renewed 1976	1971/3
Union of Soviet Socialist Republics	II			General Exchanges Agreement Between the Government of Canada and the Government of the Union of Soviet Socialist Republics	Signed and in force 20 October 1971 Renewed 1976	1971/40
Union of Soviet Socialist Republics	IV		NRC/Academy of Sciences	Agreement on Scientific Cooperation Between the Cooperation Between the National Research Council of Canada and the Academy of Sciences of the USSR	Signed September 1972 In force 1 January 1973 Renewed 1975 This agreement replaced the original NRC/ Academy of Sciences arrangement set forth in an Exchange of Letters in 1959.	

Country or Supranational Entity	Type	Type III Science or Technology Sector	Responsible and/or Signatory Agency	Title and/or Description	Date	Canada Treaty Series Reference No.
Union of Soviet Socialist Republics	III	Arctic Sciences		Joint memorandum confirming the establishment of cooperation in Arctic science	24 February 1972	
Yugoslavia	IV		NRC/FCCSA	Protocol Between the Federal Council for the Coordination of Scientific Activities of the Socialist Federal Republic of Yugoslavia and the National Research Council of Canada	30 September 1965 This protocol had no terminal date, but is considered no longer valid.	
Yugoslavia	I			Exchange of Letters Between Canada and the Socialist Federal Republic of Yugoslavia concerning the encouragement of further contacts and exchanges in science and technology, and in the industrial application of science and technology	3 November 1971	

Appendix B

Science and Technology Agreements with the United States

Canadian-American science and technology agreements are all of a Type III classification – agreements in specific scientific or technological fields or covering particular subjects. They are listed by science and technology sector, and sublisted by chronology. The list includes one trilateral – the Canada/United States/European Community Memorandum of Understanding on Aerosat.

In its 1972-1973 survey of Canada's science and technology relationship with the United States, the Ministry of State for Science and Technology listed 24 formal treaties and agreements. MOSST included four defence arrangements and two regulatory agreements (one on the construction of a LORAN-C station and one on uranium safeguards) that are excluded here. MOSST also included four agreements that are extensions or modifications of earlier treaties. On our list, amendments are integrated with the original treaty and regarded as parts of a single agreement. The status of the remaining 11 intergovernmental agreements, and the three interagency memoranda of understanding additionally culled from the MOSST survey, is up-dated where necessary. Ten new agreements have been signed, or are about to be signed, since MOSST completed the review, and to their list we are also adding three agreements concluded before 1973, for a total of 27.

Science and Technology Sector	Responsible and/or Signatory Agency	Title and/or Description	Date	Canada Treaty Series Reference No.
Atomic Energy	AECL and Eldorado Mining and Refining Ltd./US Atomic Energy Commission	Agreement for Cooperation Concerning Civil Uses of Atomic Energy between the Government of Canada and the Government of the United States of America	Signed 15 June 1955 In force 21 July 1955 Amendment signed 26 June 1956 In force 1 March 1957 Further amended 27 July 1959, 14 July 1960, 11 July 1962 In effect to 13 July 1980	1955/15 1957/8 1959/16 1960/17 1962/10
Atomic Energy	AECL/USAEC-ERDA	Memorandum of Understanding between Atomic Energy of Canada Limited and the US Atomic Energy Commission providing for the exchange of information and personnel and cooperative research in the development of heavy-water moderated reactors	1960 Terminated 1976 and replaced by a similar MOU between AECL and AEC's successor, the Energy Research and Development Agency	
Atomic Energy	AECL-AECB-Ontario Hydro/ AEC-USACDA	TRUST Program. A cooperative research program studying the applicability of tamper-resistant unattended safeguard techniques, developed by the US Arms Control and Development Agency, to on-power fuelled reactors	Program terminated 1976 Replaced by an AECL-AECB/ IAEA arrangement with US participation on an ad hoc basis	
Environment	International Joint Commission	Agreement Between Canada and the United States of America on Great Lakes Water Quality	Signed and in force 15 April 1972	1972/12

Science and Technology Sector	Responsible and/or Signatory Agency	Title and/or Description	Date	Canada Treaty Series Reference No.
Environment	Ministry of Transport/U.S. Coast Guard	Exchange of Notes Between the Government of Canada and the Government of the United States of America Concerning a Joint Marine Pollution Contingency Plan	Signed and in force 19 June 1974	1974/22
Seismology	Defence Research Board/U.S. Advanced Research Projects Agency (ARPA)	Exchange of Notes Between the Government of Canada and the Government of the United States of America Concerning the Continuing Operation in Canada of Mobile Seismic Observatories (Project Vela Uniform)	18 May and 28 and 29 June 1965 Modified and extended 27 June 1968, 19 December 1974 In effect 1 July 1974 to 30 June 1977	1965/10 1968/7 1974/41
Space	DRB/NASA	Exchange of Letters Between the Defence Research Board and the National Aeronautics and Space Administration for cooperation in a joint venture to explore the ionosphere by means of satellites (Alouette)	25 August, 18 November and 16 December 1959	
Space	DOT/NASA	Memorandum of Understanding Between the Department of Transport and the National Aeronautics and Space Administration Concerning the Testing and Experimental Communications Satellites, and an Exchange of Notes Constituting an Agreement	MOU, 4 and 25 April 1963 Exchange of Notes, 13 and 23 August 1963	1963/13
Space	DOT/NASA	Exchange of Notes Between Canada and the United States of America Concerning a Cooperative Program for the Establishment and Operation of a Command and Data Acquisition Station in Canada to serve an Operational Meteorological Satellite System being established by the United States (NIMBUS)	28 December 1962 Terminated 4 February 1964	1962/21 1964/20

Science and Technology Sector	Responsible and/or Signatory Agency	Title and/or Description	Date	Canada Treaty Series Reference No.
Space	NRC/NASA	Exchange of Notes Between Canada and the United States of America Concerning the Establishment of a Satellite Tracking Station near St. John's, Newfoundland	Signed and in force 24 August 1960	1960/19
Space	NRC/DOD (USAF)	Exchanges of Notes Between the Government of Canada and the Government of the United States of America Concerning the Joint Use, Operation and Maintenance of the Churchill Research Range	14 June 1960 Amended and extended 11 June 1965, 18 December 1970, 29 June 1973 Extended June 1976 for a further three years	1960/12 1965/9 1970/32 1973/25
Space	DRB/NASA	Memorandum of Understanding Between the Canadian Defence Research Board and the National Aeronautics and Space Administration for cooperation in a joint program of ionospheric research by means of Satellites (ISIS), and an Exchange of Notes Constituting an Agreement	MOU, 23 December 1963 Exchange of Notes, 6 May 1964 Amended 11 May 1970	1964/6 1970/14
Space	RCAF/USAF	Exchange of Notes Between the Government of Canada and the Government of the United States Concerning the Establishment of a Cooperative Meteorological Rocket Project at Cold Lake, Alberta	Signed 29 September and 6 October 1966 In force 6 October 1966 Amended and extended 24 April 1969	1966/30 1969/22
Space (Aeronautics)	ITC/NASA	Exchange of Notes Between the Government of Canada and the Government of the United States of America Concerning Joint Participation in the Augmentor Wing Flight Test Project	19 October and 10 November 1970 Extended 24 March 1975 to 1 July 1977	1970/27 1975/10

Science and Technology Sector	Responsible and/or Signatory Agency	Title and/or Description	Date	Canada Treaty Series Reference No.
Space	NRC/NASA	Exchange of Notes Between the Governments of Canada and the United States Concerning the Establishment and Operation of a Temporary Space Tracking Facility in Newfoundland in connection with Project Skylab	Signed 20 December 1971 and 23 February 1972 Extended 26 November 1974 to 30 June 1976	1972/4 1974/38
Space	EMR(CCRS)/ NASA	Exchange of Notes Between the Government of Canada and the Government of the United States of America constituting an Agreement Concerning a Joint Program in the Field of Experimental Remote Sensing from Satellites and Aircraft (ERTS/Landsat)	Signed and in force 14 May 1971 Amended and extended 22 March 1976 In effect from 14 May 1975 for a period of five years	1971/19 1976/21
Space	DOC/NASA	Memorandum of Understanding Between the Department of Communications of Canada and the National Aeronautics and Space Administration of the United States of America for Cooperation in an Experimental Communications Technology Satellite Project (CTS), and Exchange of Notes Constituting an Agreement	Signed 21 and 27 April 1971 In force 27 April 1971	1971/14
Space	DOC/FAA/ESA	Memorandum of Understanding on a joint program of experimentation and evaluation using an Aeronautical Satellite capability (Aerosat) between the Government of Canada, the United States Federal Aviation Administration, and the European Space Research Organization	August 1974	
Space		Exchange of Notes Concerning Studies of the Earth's Magnetosphere, Carried out by launching two Black Brant rockets in January 1975 from the DEW Station at Cape Parry, NWT	4 October and 12 December 1974	

Science and Technology Sector	Responsible and/or Signatory Agency	Title and/or Description	Date	Canada Treaty Series Reference No.
Space	DOE/NOAA	Memorandum of Understanding Between Environment Canada and the National Oceanographic and Atmospheric Administration Concerning the National Environment Satellite Service, Inland Waters Directorate, Environmental Management Service GOES Data Collection Program	October 1975	
Space	NRC/ERDA	Exchange of Notes on "Operation Periquito," a barium plasma probe of the magnetospheric cleft, carried out by rocket launches and related experiments at Cape Parry, NWT	25 November 1975 In force through September 1978	
Space	EMR(CCRS)/ NASA	Memorandum of Understanding Between the Canada Centre for Remote Sensing and the National Aeronautics and Space Administration Concerning the Retransmission of Hydromet Data, and the Landsat Follow-up Program	In effect for 15 months, 1975/1976	
Space	NRC/NASA	Memorandum of Understanding Between the National Research Council and the National Aeronautics and Space Administration for a Cooperative Program Concerning the Development and Procurement of a Space Shuttle Attached Remote Manipulator System, and an Exchange of Notes Constituting an Agreement	MOU, 9 and 18 July 1975 Exchange of Notes, 23 June 1976	
Space	NRC/NSF	Exchange of Letters Between the National Research Council and the National Science Foundation on cooperation in balloon flight technology	August 1976	

Science and Technology Sector	Responsible and/or Signatory Agency	Title and/or Description	Date	Canada Treaty Series Reference No.
Space	CCRS and Agriculture Canada/ NASA, DOA, and NOAA	Memorandum of Understanding for Cooperation in the Development of a Global Crop Inventory System (LACIE) between the Canada Centre for Remote Sensing and Agriculture Canada and the National Aeronautics and Space Administration, the US Department of Agriculture, and the National Oceanographic and Atmospheric Administration	March 1978	
Space	CCRS/NASA	Memorandum of Understanding for Cooperation in the development of a "proof-of-concept" all-weather oceanographic Satellite (SEASAT)	September 1978	
Transportation (and Aeronautics)	MOT/DOT	Memorandum of Understanding Between the Ministry of Transport and the Department of Transport on a joint program of transportation research and development involving V/STOL; high-speed ground transportation; air navigation and air traffic control equipment; transportation safety; technological forecasting and information systems	June 1970 Continuing	

Notes

I. Introduction

1. Eugene B. Skolnikoff, "Science, Technology and the International System," in *Science, Technology and Society*, ed. Ina Spiegel-Rosing and Derek de Solla Price, London and Beverly Hills, 1977, pp. 507, 515, 517.

2. *Science, Technology and Diplomacy in the Age of Interdependence*, Study prepared by the Congressional Research Service for the US House of Representatives, Subcommittee on International Security and Scientific Affairs of the Committee on International Relations, June 1976, p. 6.

3. Science Council of Canada, *Canada, Science and International Affairs*, Report No. 20, Information Canada, April 1973, p. 30.

4. *Foreign Policy for Canadians*, Information Canada, Ottawa, 1970, pp. 14, 18-19, 27.

5. *Ibid., Europe*, p. 27.

II. The Policy-Making Structure of the Federal Government

1. Science Council of Canada, *Canada, Science and International Affairs, op. cit.*, p. 32.

2. The office was dismantled in 1977 and its functions were diffused across other IT&C divisions.

3. Canada, House of Commons, *Standing Committee on External Affairs and Defence*, 19 May 1971, 27:7.

4. Order-in-Council Authorizing the Issuance of a Proclamation Establishing the Ministry of State for Science and Technology.

5. Brigitte Schroeder-Gudehaus, "Science, Technology and Foreign Policy," in *Science, Technology and Society, op. cit.*, p. 486. See also, Science Council of Canada, *Canada, Science and International Affairs, op. cit.*, pp. 32-33.

6. John J. Kirton, "Foreign Policy Decision-Making in the Trudeau Government: Promise and Performance," *International Journal* XXXIII, Spring 1978, pp. 292-293.

7. Peter Aucoin and Richard French, *Knowledge, Power and Public Policy*, Science Council of Canada, Background Study No. 31, Information Canada, November 1974.

8. Canada, Senate, *Special Committee on Science Policy*, Brief presented by the Hon. C. M. Drury, Minister of State for Science and Technology, 3 December 1975, 1:54.

9. For MOSST's own view of its role, including that of developing "a global science and technology policy," see "Canada's New Ministry of State for Science and Technology," *Science Forum* 24 December 1971, pp. 16-18 (transcript of a taped interview with Dr. Aurele Beaulnes, Secretary of the Ministry).

10. For example, at the time of the committee's formation, there were "approximately 1880 Canadian and 2228 locally-engaged employees of some 22 departments, boards, agencies and other organizations of government appointed or employed at 115 locations in 69 countries other than Canada." J. R. Maybee, "ICER and Its Two-Year Search for an Approach to Integration," *International Perspectives*, September-October 1972, pp. 40-41.

11. Canada, Senate, *Special Committee, op. cit.*, 1:59.

12. Science Council of Canada, *Canada, Science and International Affairs, op. cit.*, p. 46.

13. Cited in *Science and Technology in the Department of State*, Study prepared by the Congressional Research Service for the US House of Representatives, Subcommittee on International Security and Scientific Affairs of the Committee on International Relations, June 1974, p. 78.

14. Science Council of Canada, *Canada, Science and International Affairs, op. cit.*, pp. 43-44.

15. One remarkable exception is the Department of Fisheries and the Environment, which has put out a report that could be a model for other departments. *An Overview of International Intergovernmental Environmental Relations*, Liaison and Coordination Directorate, 28 April 1977.

III. Bilateral Science and Technology Agreements

1. Canada Treaty Series, 1968/3.
2. Cited in *Science and Technology in the Department of State, op. cit.*, p. 78.
3. *Ibid.*, p. 86.
4. Peter C. Dobell, *Canada's Search for New Roles: Foreign Policy in the Trudeau Era,* London, 1972, p. 42.
5. James E. Hyndman, "National Interest and the New Look," *International Journal* XXVI, Winter, 1970-1971, pp. 5-6.
6. *Foreign Policy for Canadians: Europe, op. cit.*, p. 15.
7. Théo Lefèvre, "La Cooperation scientifique et technologique entre le Canada et la Belgique," *Bulletin des Amitiés Belgo-Canadiennes,* November 1970.
8. *Ibid.*
9. "Belgium-Canada Agreement on Scientific, Industrial and Technological Cooperation," *External Affairs* 23, June 1971, p. 207.
10. Dobell, *Canada's Search for New Roles, op cit.*, p. 42. The second meeting of the Mixed Commission held under the provisions of the 1967 cultural accord did not take place until 11-15 October 1976, a month before the Quebec provincial elections. At that time, Quebec (along with five other provinces) sent a delegate. *International Canada* VII, October 1976, p. 258.
11. "Belgium-Canada Agreement on Scientific, Industrial and Technological Cooperation," *op. cit.*, p. 207.
12. Department of External Affairs, *Agreement on Scientific, Industrial and Technological Cooperation Between Belgium and Canada.* Third Meeting of the Joint Commission, Summary and Results of the Discussions, Ottawa, 15-18 September 1975. (Copy provided by Ministry of State for Science and Technology.)
13. *Ibid.*
14. *Ibid.*
15. *Ibid.*
16. *Ibid.*
17. *Ibid.*
18. *Science and Technology in the Department of State, op. cit.*, p. 79.
19. *Ibid.*
20. Canada, House of Commons, *Debates,* 27 April 1971, p. 5254.
21. Excluding, of course, such regulatory agreements as the United Nations Convention on International Liability for Damage Caused by Space Objects, or the multilateral INTELSAT agreement. Space cooperation may also take place in the context of another category of agreement. For example, the Interdepartmental Committee on Space lists the Type IV NRC accord with the Japan Society for the Promotion of Science as a space agreement.
22. R. J. Colley, ed., *Space and Upper Atmosphere Programs in Canada 1975,* Space Research Facilities Branch, National Research Council of Canada, Information Canada, Ottawa, 1976, p. 1.
23. Sounding rocket sales in 1974, for example, added up to $2.8 million, compared with $29.6 million in satellite supply activities. *Ibid.*, pp. 69-70.
24. Arthur J. Cordell and James Gilmour, *The Role and Function of Government Laboratories and the Transfer of Technology to the Manufacturing Sector,* Science Council of Canada, Background Study No. 35, Information Canada, April 1976, p. 249.
25. W. M. Auld, et al., "The Benefits to Canadian Industry Through Participation in Space Activities," United Nations Conference, *Space Exploration and Application,* Vienna, 14-27 August 1968.
26. The Air Industries Association of Canada, *A Space Policy for Canada – An Industrial Viewpoint,* February 1974, p. 9. (Copy provided by AIAC.)
27. J. D. MacNaughton (Vice-President, Spar Aerospace), "Role of Industry in a Canadian Space Program," CASI/AIAA Meeting, *Space – 1972 Assessment,* Ottawa, 10-11 July 1972, Paper No. 72-738.
28. AIAC, *A Space Policy for Canada, op. cit.*, pp. 11-12.
29. Charles Dalfen (Department of Communications), "Space Assessment

1972 – Arrangements and Prospects for Cooperation," CASI/AIAA Meeting, *op. cit.*, Paper No. 72-740.

30. AIAC, *A Space Policy for Canada, op. cit.*, p. 42.

31. *The Post-Apollo Space Program: Directions for the Future,* Space Task Group Report to the President, September 1969, p. iii, quoted in *World-Wide Space Activities.* Report prepared by the Congressional Research Service for the US House of Representatives, Subcommittee on Space Science and Applications of the Committee on Science and Technology, September 1977, p. 34.

32. Burl Valentine, "Obstacles to Space Cooperation: Europe and the Post-Apollo Experience," *Research Policy* I, 1971-1972, p. 109.

33. *World-Wide Space Activities, op. cit.*, p. 32.

34. *Ibid.*

35. *The Financial Post,* 28 May 1977.

36. Interdepartmental Committee on Space, *Annual Report 1976,* November 1977.

37. Science Secretariat, *Upper Atmosphere and Space Programs in Canada,* Special Study No. 1, February 1967, pp. 109-110. This conclusion was reiterated by the Science Council of Canada, *A Space Program for Canada,* Report No. 1, Queen's Printer, Ottawa, July 1967.

38. C. M. Drury, "International Aspects of Possible Future Canadian Participation in Space Programs," *Canadian Aeronautics and Space Journal,* February 1971, pp. 33-35.

39. *Ibid.*

40. *Ibid.*

41. In this period, "quite a debate raged" between states such as Germany, which advocated participation in post-Apollo, and those such as France, which advocated spending the bulk of European resources on development of an independent launch capability. Danelle K. Simonelli, "Cooperation in Space," *European Community,* January-February 1978, p. 19.

42. C. M. Drury, "International Aspects," *op. cit.*, p. 34.

43. Valentine, "Obstacles to Space Cooperation," *op. cit.*, p. 106.

44. AIAC, *A Space Policy for Canada, op. cit.*, p. 3.

45. MOSST, *News Release,* 16 July 1974.

46. National Research Council, *Report of the President, 1975-1976,* Information Canada, Ottawa, p. 102.

47. AIAC, *A Space Policy for Canada, op. cit.*, p. 3.

48. *Ibid.*, pp. 3-45.

49. Ministry of State for Science and Technology, *The Make or Buy Policy, 1973-1975,* November 1975, p. 4.

50. MOSST, *News Release,* 16 July 1974. The final cost of this project definition phase was $2.5 million.

51. Memorandum of Understanding Between the National Aeronautics and Space Administration and the National Research Council of Canada for a Cooperative Program Concerning the Development and Procurement of a Space Shuttle Attached Remote Manipulator System, July 1975. (Copy provided by NRC.)

52. Formerly the Government and Commercial Systems Division of RCA, Montreal. Spar Technology Limited (STL), a wholly-owned subsidiary of Spar Aerospace Products Limited, acquired the RCA division on 1 January 1977.

53. NASA's proposed pricing policy, made public late in 1976, gives most-favoured client status to the US Department of Defense.

54. *The Financial Times,* 15 May 1978.

55. The agreement originally called for procurement of two two-arm (right and left hand) RMS units, for the first two orbiters.

56. ICS, *Annual Report 1976,* p. 10.

57. Spar Aerospace has recently entered into an agreement with Grumman Aerospace Corporation of New York to develop remotely controlled arms for a construction platform in space (*The Globe and Mail,* Toronto, 24 May 1978).

58. *World-Wide Space Activities, op. cit.*, p. 39. In 1975 NASA accepted

one Japanese proposal for inclusion in a Spacelab mission.

59. For example, NRC assumes "on behalf of the ICS Secretariat," the responsibility for scientific liaison and coordination. DOC's International Branch "assists" the ICS Secretariat in performing its functions in international relations. ICS, *Annual Report 1976,* p. 7. The members of ICS are DOC (Chair), NRC, MOSST, IT&C, EMR, Transport, Defence, External Affairs and Environment/Fisheries. Treasury Board is an observer.

60. Science Council of Canada, *A Space Program for Canada, op. cit.*

61. The hosting institutions included not only universities and government departments but also commercial enterprises and provincial organizations. In 1971, for example, three Brazilians in the field of chemistry and ceramic engineering were received by 12 industries (including Domtar, Canadian Refractories, Ohio Brass, Canadian Porcelains, and International Drilling Fluids), as well as by the federal Department of Energy, Mines and Resources, the Ontario Department of Mines, the Ontario Research Foundation, the Manitoba Department of Mines, and the Research Council of Saskatchewan.

IV. Inventory of Cooperation

1. *Foreign Policy for Canadians: International Development, op. cit.,* p. 18.

2. Canada Treaty Series, 1971/50.

3. "Mr. Sharp Visits Five African Nations," *External Affairs* 23 May 1971, p. 156.

4. *Foreign Policy for Canadians: Latin America, op. cit.,* p. 16.

5. George Radwanski, "Trudeau in Latin America," *International Perspectives,* May-June 1976, p. 7.

6. Department of External Affairs, *Press Release,* No. 40, 2 April 1973.

7. Department of External Affairs, *Joint Communiqué of the Second Canada/Mexico Ministerial Committee Meeting,* No. 10, 30 January 1974.

8. Visit of Canadian Parliamentary Delegation in Mexico, 21-28 March 1977, *Joint Communiqué.* (Copy provided by Ministry of State for Science and Technology.)

9. Sheldon Gordon, "Canadian Aid Policy," *International Perspectives,* May-June 1976, p. 23.

10. Exchange of Scientists Agreement Between the National Research Council of Canada and the Conselho Nacional de Pasquisas of Brazil. (Copy provided by NRC.)

11. Department of External Affairs, Visit of the Secretary of State for External Affairs to Brazil, *Joint Communiqué,* No. 2, 13 January 1977.

12. *Ibid.*

13. *The Globe and Mail,* Toronto, 29 March 1978.

14. William G. Saywell, "Reflections of a New China Hand," *International Journal* XXIX, Summer 1974, p. 331. Saywell is a former Canadian diplomat who was posted to Peking.

15. *Ibid.*

16. Canada, House of Commons, *Debates,* Information Canada, 19 October 1973, p. 7037.

17. Gérard Hervouet, "Sino-Canadian Relations: Resignation and Optimism," *International Perspectives,* November-December 1977, p. 27.

18. Comment by *Globe and Mail* correspondent John Burns, quoted in Maureen A. Molot, "Canada's Relations with China Since 1968," in *Foremost Nation: Canadian Foreign Policy in a Changing World,* ed. N. Hillmer and G. Stevenson, p. 258. See also, the similar comment by William Saywell, "Pierre and the Pacific: A Post-Mortem," *International Journal* XXIII, Spring 1978, p. 412.

19. Department of Trade and Commerce, *News Release,* 53/66, 20 June 1966.

20. *Ibid.,* 70/66, 16 September 1966.

21. NATO Ministerial Communiqué, 10 December 1971.

22. *Canada Commerce* 40, IT&C, Information Canada, June-July 1976, p. 6.

23. Quoted in I. A. Litvak and C. H. McMillan, *Inter-governmental Arrangements for East-West Cooperation in the Application of Industrial Technology,* East-West Commercial Relations Series, Institute of Soviet and East European Studies, Carleton University, Working Paper No. 3, March 1974, pp. 10-11. See also a revised version of this paper: "Intergovernmental Cooperation Agreements as a Framework for East-West Trade and Technology Transfer," in *Changing Perspectives in East-West Commerce,* ed. C. H. McMillan, Lexington, Mass., 1974, pp. 151-172. .

24. *Ibid.,* pp. 12-13.

25. IT&C figures, in millions of dollars, are 1974, 18.8; 1975, 54.9. *Canada Commerce, op cit.,* pp. 6, 10.

26. Litvak and McMillan, *Inter-governmental Arrangements, op. cit.,* p. 14.

27. "Pierre to Visit Russia," *Citizen,* Ottawa, 23 April 1970.

28. The text of the agreement, along with addresses by Trudeau and Kosygin and the Joint Communiqué, was published in *External Affairs,* 23 November 1971, pp. 406-420.

29. Department of External Affairs, *Press Release,* 40/71, 3 June 1971.

30. Department of External Affairs, *Canadian-Yugoslav Communiqué,* No. 84, 7 November 1971.

31. Litvak and McMillan, *Inter-governmental Arrangements, op. cit.,* p. 9. The same holds true of a provision annexed to the Canadian-Bulgarian Trade Agreement of 1974.

32. *Conference on Security and Cooperation in Europe, Final Act,* Ottawa, Information Canada, 1975. The science, technology, and environment provisions are on pp. 24-31. The text of the accord, with a commentary by G. G. Crean, is also reprinted in *Behind the Headlines* XXXV, September 1976.

33. *Ibid.,* p. 59.

34. *Concluding Document,* Belgrade Meeting, 1977, Representatives of the Participating States of the Conference on Security and Cooperation in Europe, Held on the Basis of the Provisions of the Final Act Relating to the Follow-up to the Conference, 8 March 1978.

35. Department of External Affairs, *Joint Communiqué Concerning the Visit of the Secretary of State for External Affairs to Poland,* No. 93, 3 October 1975.

36. Statement of Dr. Allan Kassof, US House of Representatives, Subcommittee on Domestic and International Scientific Planning and Analysis of the Committee on Science and Technology, *Hearings,* 17-20 November 1975, p. 86.

37. *The Globe and Mail,* Toronto, 17 July 1978.

38. "Canada's Postwar Economic Relations with the USSR: A Retrospective Appraisal," Paper prepared for a volume on Canada-Soviet Relations to be edited by A. Balawyder. (Copy provided by Prof. McMillan, Institute of Soviet and East European Studies, Carleton University.)

39. US House of Representatives, Scientific Planning Committee, *Hearings, op. cit.,* p. 90.

40. *Foreign Policy for Canadians: Europe, op. cit.,* p. 26.

41. MOSST, *News Release,* 24 October 1973.

42. *Foreign Policy for Canadians: Europe, op. cit.,* p. 17.

43. Charles Pentland, "Linkage Politics: Canada's Contract and the Development of the European Community's External Relations," *International Journal* XXXII, Spring 1977, p. 216.

44. *The Times,* London, 24 November 1971.

45. Don Peacock, "Selling CANDU to Britain: A Venture in Public Diplomacy," *International Perspectives,* January-February 1976, pp. 3-8.

46. Office of the Prime Minister, *Visit of the Prime Minister of India to Canada, Joint Communiqué,* Press Release, 24 June 1973. (Copy provided by PMO.)

47. *Foreign Policy for Canadians: Pacific, op. cit.,* p. 23.

48. Except where otherwise indicated, the following quotations are all

from the Ministry of State for Science and Technology, Cooperation Branch, Bilateral Cooperation Division, *Canada-USA Relations in Science and Technology,* Unpublished Report, October 1972-August 1973. (Copy provided by MOSST.)

49. See Section III, p. xx.

50. Mitchell Sharp (Secretary of State for External Affairs), "Canada-US Relations: Options for the Future," *International Perspectives,* Special Issue: Autumn 1972, p. 21.

51. *Foreign Policy for Canadians: Europe, op. cit.,* pp. 26-27.

52. Quotations in this paragraph are all from Sharp, "Canadian-US Relations," *op. cit.,* pp. 20-24.

53. *Ibid.,* p. 23.

54. *Foreign Policy for Canadians: Europe, op. cit.,* p. 27.

55. Charles Lynch, "Sabre-Rattling on US Relations," *Citizen,* Ottawa, 15 December 1975.

56. United States Information Service, "Energy: Canada and the United States Face the Challenges," Remarks by United States Ambassador Thomas Ostrom Enders to the Edmonton Chamber of Commerce, 21 June 1976.

57. J. H. Warren (Canadian Ambassador to the United States), "Third Option Can Work Well for both Canada and the US," *International Perspectives,* Special 1976 Bicentennial Issue, p. 10.

58. Garth Stevenson, "The Third Option," *International Journal* XXXIII, Spring 1978, pp. 424-431.

59. "Visit of Prime Minister to Japan," *International Canada* VII, October 1976, p. 233.

60. Statement of the Secretary of State for External Affairs, House of Commons, *Minutes of Proceedings and Evidence of the Standing Committee on External Affairs and National Defence,* 22 October 1974, 2:8.

61. Lorne Kavic, "Canada-Japan Relations," *International Journal* XXVI, Summer 1971, p. 581.

62. *Joint Communiqué of the Sixth Canada-Japan Ministerial Meeting,* quoted in *International Canada* II, September 1971, p. 184.

63. Ministry of State for Science and Technology, *Joint Statement on the Occasion of the Visit to Japan by a Canadian Science and Technology Mission,* 15 March 1972. (Copy provided by MOSST.)

64. Canada, Senate, *Report of the Standing Committee on Foreign Affairs Respecting Canadian Relations with Countries of the Pacific Region,* March 1972, p. 22.

65. D. Gordon Longmuir, "Planning Policy to Reflect the New Reality of Japan," *International Perspectives,* May-June 1972, p. 33.

66. An NRC agreement with the Japan Society for the Promotion of Science was signed in 1975. See p. xx.

67. *Joint Communiqué* between Prime Minister Kakuei Tanaka and Prime Minister Pierre Elliott Trudeau, Ottawa, 24 September 1974. (Copy provided by MOSST.)

68. Stephen Heeney (Department of External Affairs), "Common Goal of Expansion Unites Canada and Japan," *International Perspectives,* January-February 1975, p. 17.

69. Ivan L. Head, "Canada's Pacific Perspective," *Pacific Community* IV, October 1974, pp. 18-19.

70. Frank C. Langdon, "Canada's Struggle for Entrée to Japan," *Canadian Public Policy* XI, Winter 1976, pp. 55-56.

71. Keith A. J. Hay and S. R. Hill, *Canada-Japan: The Export-Import Picture 1977,* Canada-Japan Trade Council.

72. Secretary of State for External Affairs, "Towards a New Canada-Japan Partnership," *Statement,* Japanese Press Club, 25 June 1975, p. 11.

73. Transcript of Prime Minister Trudeau's Press Conference, Tokyo, Japan, 26 October 1976.

74. "Science and Technology Agreement with the Federal Republic of Germany," *External Affairs* XXIII, August 1971, pp. 314-315.

75. Ministry of State for Science and Technology, *Final Report of the*

Third Consultative Meeting under the Canada-FRG Cooperative Agreement on Science and Technology, Ottawa, 26-28 November 1975. (Copy provided by MOSST.)

76. *Joint Summary Report of the Fourth Consultative Meeting under the German-Canadian Cooperative Agreement on Science and Technology,* Bonn, 10-12 May 1977. (Copy provided by MOSST.)

77. *Report of the Third Consultative Meeting, op. cit.*

78. Department of Fisheries and the Environment, Liaison and Coordination Directorate, *An Overview of International Intergovernmental Environmental Relations*, unpublished report, 28 April 1977. (Copy provided by DFE.)

79. *The Globe and Mail,* Toronto, 7 April 1978.

80. "Canada's Relations with Europe," *External Affairs* XXII, January 1970, p. 16.

81. *Foreign Policy for Canadians: Europe, op. cit.*, p. 26.

82. Besides the government of Canada, the parties to the agreement are actually three: the European Economic Community, the European Atomic Energy Community, and the European Coal and Steel Community. In discussions of the agreement, however, commentators usually refer simply to the Community, or the EC.

83. Quotations in the above paragraph are all from a comprehensive analysis by E. E. Mahant, "Canada and the European Community: The New Policy," *International Affairs* LII, October 1976, pp. 551-564.

84. Canada Treaty Series, 1976/35.

85. More, at least, than the "Trudeau puff" characterization offered by Uwe Kitzinger, former head of the foreign secretariat at the EEC. *Citizen,* Ottawa, 17 November 1977.

86. *Ibid.,* 8 December 1976.

87. Both Roy Jenkins, President of the EC Commission, and External Affairs Minister Jamieson agreed on this point during the second meeting of the Joint Cooperation Committee, *The Globe and Mail,* Toronto, 9 March 1978.

88. Charles Pentland, "Linkage Politics," *op. cit.*, p. 231. On this point see also, Gerald Wright, "Europe: Policy-Planning on a See-Saw," *International Journal* XXXIII, Spring 1978, pp. 391-392

89. Peter C. Dobell, *Canada's Search for New Roles, op. cit.,* pp. 41-42. On the prime minister's trip, see "Restoring Relations with France and Opening New Doors to Europe," *International Perspectives,* January-February 1975, pp. 3-6.

90. Dobell, *Canada's Search for New Roles, op. cit.*, p. 47. Individual scientific exchanges were also encouraged. Some 85 Canadians – a very large increase in number over earlier years – were federally supported between 1967 and 1971 on visits to France, ranging in duration from two weeks to a year, and covering such fields as engineering, chemistry, physics, mathematics, biology, oceanography, metallurgy, minerology, forestry, architecture, and medicine.

91. NRC was never satisfied with the arrangement and in 1971 negotiated a second Type IV agreement to replace it (see p. xx). The NRC exchange and a 1968 understanding between Atomic Energy of Canada Limited and the Commissariat de l'Energie atomique are further examples of the government's effort to sustain contact in areas of practical concern during a diplomatically trying time.

92. *Sous-Commission Scientifique de la VIème Session de la Commission Mixte Franco-Canadienne,* 22-23 May 1973. (Copy provided by Health and Welfare Canada.)

93. Rick McGrath, "The Canada-France-Hawaii Telescope: We'll See 'First Light' in 1978," *Science Forum* XIV, December 1976, p. 9.

94. Science Council of Canada, *Canada, Science and International Affairs, op. cit.*, pp. 52-56. The report also listed Canadian membership in close to 160 scientific and technical non-governmental organizations.

95. "NATO Looks at its Science Program," Nature 272, 20 April 1978, p. 657. On Canadian involvement in CCMS, see the article by Patrick Kyba in *International Perspectives*, July-August 1977, pp. 11-14.

V. Summary and Conclusion

1. *Foreign Policy for Canadians, op. cit.*, pp. 20-21, 38-39.
2. *Ibid.*, p. 17.
3. Science Council of Canada, *Technology Transfer: Government Laboratories to Manufacturing Industry*, Report No. 24, Information Canada, Ottawa, December 1975, p. 10.
4. Sanford A. Lakoff, "Science Policy for the 1970s: Canada Debates the Options," *Science*, 12 January 1973, p. 151.

Publications of the Science Council of Canada

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Third Annual Report, *1968-69* (SS1-1969)
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