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CANADA

Report of the
National Advisory Board
on Science and Technology

COMMITTEE ON FEDERAL SCIENCE AND TECHNOLOGY PRIORITIES: Phase II

Presented to the
Prime Minister of Canada



National Advisory Board on Science and Technology

Conseil consultatif national des sciences et de la technologie

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

Dear Prime Minister:

This letter transmits the final report of the NABST Committee on Federal Science and Technology Priorities. I had the honour to present to you a summary of this report during the Plenary Meeting of February 4, 1994.

There are three main messages in the Report. First and foremost, the government should manage its \$6 billion annual investment in S&T as a distinct strategic asset. Managers of federal organizations should be held accountable for implementation of an S&T strategy that meets the objectives of the government.

Second, the government should adopt two main objectives for its S&T programming: the development of a knowledge-thirsty society, and market-driven technology development. Pursuit of these objectives by all government organizations would result in a vastly more effective investment in S&T.

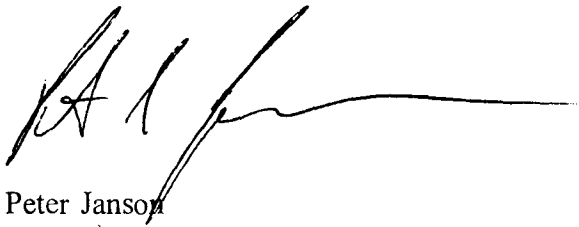
Third, the government should move quickly to establish a system for setting S&T priorities within and among federal departments and agencies. After two or more decades, the government still lacks the capacity to determine whether one S&T activity better meets government objectives than another and to reallocate S&T resources accordingly. Meanwhile, the need to set S&T priorities has been recognized, and acted upon, in several other national jurisdictions, including: Australia, New Zealand, the United Kingdom and the

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United States. Now is the time to establish a priority-setting system, while ministerial portfolios are new and you are still renewing government. Some clear direction from you to that effect is a good place to start.

Support from the top has been critical to our ability to complete our studies in this sensitive area. It will be even more decisive in ensuring implementation of our recommendations.

Yours sincerely,

A handwritten signature in black ink, appearing to read 'P. Janson', with a long horizontal flourish extending to the right.

Peter Janson
Chair
Committee on
Federal S&T Priorities

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

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Executive Summary

The allocation of financial resources suggests that S&T is clearly a priority for the government. However, government does not manage S&T as a strategic asset and there is no evidence of an explicit rationale for the distribution of S&T spending among departments and agencies.

The Committee reviewed the S&T programming of 19 federal organizations, accounting for 89 percent of federal S&T spending. The Chart on this page (larger version on p. 14) presents the findings for the selected organizations. Four principles were applied in the Committee's review of federal S&T programming: Development of a Knowledge-thirsty Society; Market-driven Technology Development; Competitiveness; and Sustainable Development.

Conclusions and Recommendations

The government should recognize and manage S&T as a distinct strategic asset; as a first step, it should require: that all departments and agencies manage their S&T activities as a distinct asset; and that central agencies monitor the total investment as an asset portfolio.

The government should advise all departments and agencies that the two main objectives for the S&T programming of the federal government are: development of a knowledge-thirsty society; and market-driven technology development. Federal S&T programming can contribute to the development of a knowledge-thirsty society by acquiring, collecting and propagating knowledge and information through such means as research, technology diffusion, education, training and public awareness activities. Federal S&T organizations can support market-driven technology development by: identifying their clients; being aware of and responding to client needs; and having current knowledge of the global competitive situation of the industry.

Cabinet should make explicit decisions about the allocation of S&T resources. The government should establish a system for priority-setting within and among federal organizations. That system should be announced, or reviewed with NABST, within six months after the Committee Report is made available to senior managers.

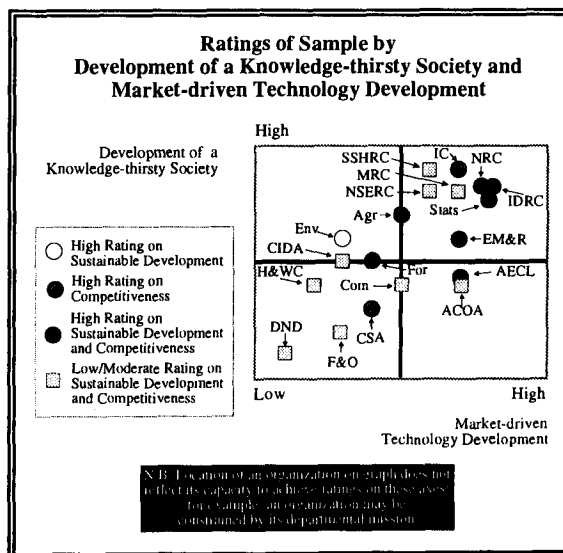


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Introduction

Priorities emerge from choices about what is important. The outcome of those choices often entails the reallocation of finite resources among competing applications. Setting priorities is a management function, as priorities express and fulfil the purpose of an organization. Indeed, an explicit understanding of the purpose, role or objectives of an organization is critical to the rational determination of its priorities.

Accordingly, a method for setting the science and technology (S&T) priorities of the federal government must have as its foundation an understanding of the actual or desired role or objectives of the federal government in supporting S&T.

The federal government invests close to \$6 billion per year in S&T, more than 11 percent of its program spending. The investment is disbursed by some 60 distinct organizations. Federally-financed research and development (R&D) accounts for about one-third of the national research and development effort (defined as gross expenditures on R&D). That comparison does not include federal expenditures on related scientific activities (RSA), which are also considered part of S&T.

An investment on that scale nonetheless falls short of the demand for funds. Choices must be made. Federal S&T priorities, based on agreement about what is important, can guide that investment to achieve maximum benefits. The objective is not to spend more or to spend less, but to spend smarter.

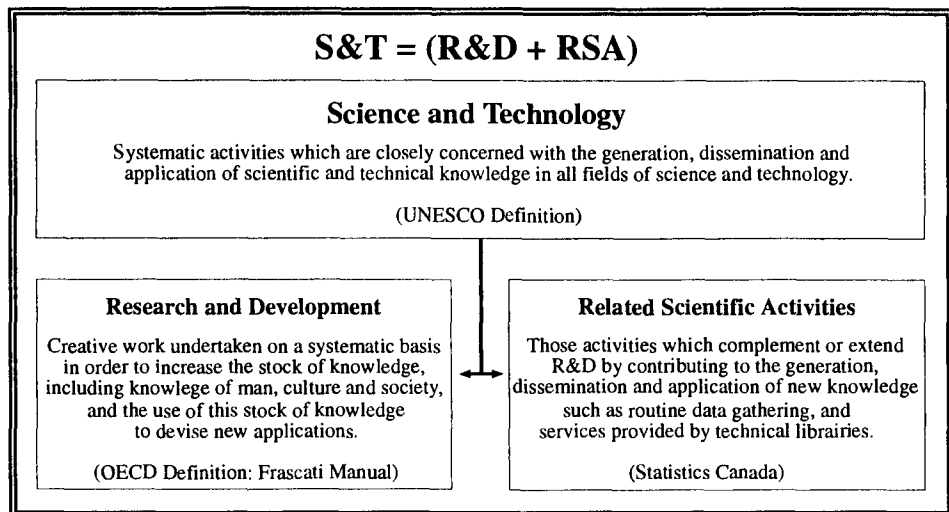


Exhibit One

Mandate

NABST approved the following mandate for the Committee on Federal S&T Priorities:

based on a clear policy framework, to develop a simple method for setting the science and technology priorities of the federal government; to apply that method to a substantial portion of federal S&T spending.

Scope

The Committee narrowed the scope of its work to a manageable sphere. Members agreed that the focus of work would be on setting spending priorities among federal departments and agencies. S&T strategy was another broad and complex issue. Thus the Committee chose not to focus on such issues as what technologies or fields of science are priority areas. The Committee also decided not to examine horizontal issues — those which are common to a number of departments and agencies (such as the balance between intramural and extramural research).

Principles

As the policy framework for its work, members selected the following four principles:

- Development of a Knowledge-thirsty Society
- Market-driven Technology Development
- Competitiveness
- Sustainable Development

These are discussed below. The winnowing process to select the principles is illustrated in Annex One.

Development of a Knowledge-thirsty Society

As traded products acquire an ever higher knowledge-content, competitiveness will depend more and more on new ideas and knowledgeable, trained people to bring those ideas to fruition and to sell them in international markets. Hence, development of a knowledge-thirsty society is understood as a necessary (but not sufficient) condition for international competitiveness and future prosperity.

In addition, the thirst for knowledge of all kinds is a characteristic of enlightened, progressive and healthy societies and cultures. A desire to understand, to know more, is an intrinsic and valuable attribute of humankind.

For these reasons, development of a knowledge-thirsty society should be a key objective for federal S&T programming. Support for that objective is an appropriate and desirable role for government.

A knowledge-thirsty society learns continuously; curiosity is a cultural attribute. A knowledge-thirsty society will support those elements of infrastructure that support learning, such as institutions which collect, preserve and disseminate information. Such a society will be aware of the importance of continuous learning as a societal posture. Learning refers to the acquisition of knowledge through education or training. It also includes the effort to develop new knowledge in all fields, whether or not the knowledge has an immediate application. The acceptance of lifelong learning as a societal posture is an essential element in building and maintaining the adaptable workforce and the discerning national marketplace that Canada will require in the future.

The Committee believes that the sharing and use of knowledge is as important as its accumulation. Indeed, knowledge is information that is interpreted, understood and, most importantly, shared. New knowledge, in all fields, should be relevant to the diverse needs of society. The Committee believes that federal S&T programs should support the development or accumulation of knowledge that is of potential interest to a broader clientele than the scientists who create it or their peers.

The objective of developing a knowledge-thirsty society can be met by activities and programs which support:

- the creation and dissemination to Canadians of new knowledge relevant to the diverse needs of society, through R&D in government, university and industry facilities;
- prospecting for, collection of, and dissemination of information of use to Canadians;
- involvement of young Canadians in federal R&D through volunteer appointments, summer work, etc.; and
- education, training and the development of a science culture.

The relevance or usefulness of knowledge and information can be assessed by the demand for it from potential users. The Committee accepts that applications for new knowledge may not be immediately apparent; in some cases, 'demand' should be interpreted as the interest of the broader research community. When government chooses to support curiosity-driven research, it should identify funds specifically, so that standards appropriate to that type of research can be applied.

Market-driven Technology Development

The application of knowledge to products and processes is another indispensable ingredient of future prosperity. As such, the Committee identifies market-driven technology development as another key principle. Federal S&T programming should support the acquisition and development of technology required by the marketplace.

Within government (i.e., intramurally), technology development that is not market-driven may serve some other goal, such as the developers' perception of what needs to be accomplished. The eventual output or product may have little relation to what the market actually requires. When resources are limited, and their allocation needs to be prioritized, **market-driven** technological development should have the priority.

The principle of market-driven technology development highlights the need for federal S&T establishments involved in the development of potentially useful technologies to establish links to private markets. Such links could be direct, in the form of joint ventures or alliances, or indirect, as when a federal laboratory responds to advice from the private sector about the direction of R&D.

The willingness of a client to pay for a federal S&T service is one measure of its worth. When federal S&T activities stimulate private sector activities of equal or greater value, there is a clear signal that the federal service is of relevance to the market.

Market direction should be applied both to intramural and extramural S&T activities: i.e., those conducted inside government or those funded by government but conducted outside. When limited, federal funds are involved, government, university and private laboratories should respond to market needs, except where there is explicit direction to support other objectives such as curiosity-driven research.

S&T organizations that have chosen to let the market drive their technology development share some common characteristics; each organization:

- has chosen its market; i.e., knows who its clients are. Imprecise identification of clients (e.g., the Minister, or all Canadians) will cause difficulties in identifying

and satisfying their needs. Non-market clients (e.g., Ministers, other government departments) may be less likely to require technology of use in the marketplace.

- is aware of client needs, through their participation and feedback in research project planning. A client advisory group is one effective method of gaining client participation, but there are others as well (e.g., contact through conferences).
- has accountability to clients for the conduct of its S&T programs. Although the organization need not always follow the advice of its clients, it owes them an explanation for its response to their recommendations.
- is aware of the global competitive position of the industries and technologies associated with its S&T programs. Such an awareness can assist in the allocation of resources among competing claims.

Competitiveness

Competitiveness is fundamental to national prosperity, indeed, it is an essential element of national survival. This was argued earlier by NABST, in its *Statement on Competitiveness*. That Report also identified competitiveness as a precondition for progress on other, pressing national issues.

The Committee understands competitiveness as the state of national economic affairs, defined by the behaviour of firms (or private sector persons), that results in a sustained and sustainable improvement of citizens standards of living and quality of life. This description recognizes that it is not sufficient, for example, to focus on rapid growth of exports; some exports add more to real incomes than others. Nor is a focus on productivity gains alone appropriate, as these could be achieved solely through reductions in jobs and income.

Similarly, the Committee recognizes that competitiveness means more than maximized economic returns to the individual. Living standards are to be understood more broadly, as elements of the quality of life. The social safety net, societal infrastructure, consumer protection, drug and product safety, and acceptable environmental conditions are, among others, a part of the standard of living in Canada. Sacrifice of these objectives for economic gain would not be accepted by most Canadians and is not proposed by the Committee.

Sustainable Development

Canadians appear committed to a fundamental change in the nature of economic development, a change that requires rethinking the concept of economic development. Sustainable development is a relatively new concept in the developed world and there are many different ways in which it can be understood. The Committee is aware that the concept is often understood to be more broad than the appreciation of the state of the physical environment and its relationship to economic development. Social, cultural and political sustainability are often included as well, as global understanding of the concept grows more sophisticated. In this report, the Committee limited itself to a narrow interpretation of sustainable development (i.e., primarily environmental), as it is the base interpretation with which most can agree. The Committee's assessments of federal organizations would change if a different interpretation had been used.

Environmental and developmental objectives should be mutually supportive throughout the development cycle, but especially at the front-end. Adoption of these supporting objectives can avert the economic and environmental costs that might otherwise occur when one or the other is overlooked.

Sustainable development is an important issue for industry today and will become more important in the future. Environmental concerns and requirements can open new business opportunities for products and services and can lead to major improvements in products and services. However, if industry does not respond to environmental imperatives, governments will intervene, whether at the national or supra-national level. Industries slow to respond may be at risk through government regulation. Competitiveness and sustainable development must therefore be allied.

Federal S&T in support of sustainable development should include work on technologies or processes which reduce consumption of natural resources, which assist firms to develop better designed, longer lasting and reusable/recyclable products and which help industry to minimize the negative impact of their manufacturing or other processes on the environment. Development of environmental standards and work on their application should also be included.

Selection of the Organizations to be Assessed

About 60 federal organizations are engaged in some form of S&T. It was not practical for the Committee to examine the S&T programming of all 60 so, in accordance with its mandate, the Committee selected a sample of departments for assessment. The

committee's first sample included twelve departments and agencies, accounting for 57 percent of federal S&T spending.

A Committee Report concerning these twelve was published in June 1993. NABST subsequently asked that the sample be expanded. The Committee then selected a further seven organizations. The S&T spending of the 19 organizations assessed by the committee accounts for 89 percent of total S&T spending.

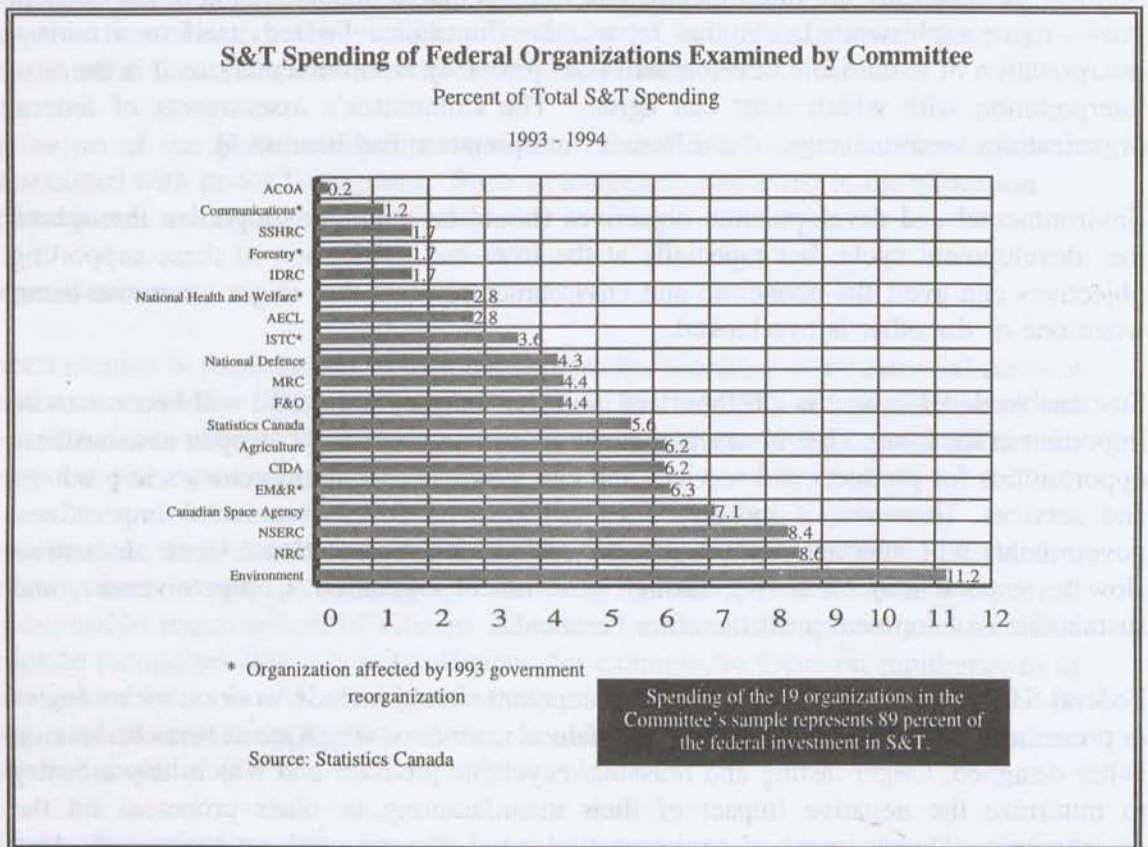


Exhibit Two

Exhibit Two presents the sample, ranked by share of total S&T spending. It includes organizations which:

- perform S&T activity intramurally as well as those which fund extramural S&T;
- fund or perform a great deal of research and development (R&D) as well as those

funding or engaged in related scientific activities (RSA);

- focus on research in the natural sciences or those which focus on the social sciences;
- spend relatively little on S&T or spend a great deal.

There has been a major reorganization of the Government of Canada since the Committee began its work. The effect of the reorganization has been to reduce the number of federal departments and agencies. In consequence, some of the organizations reviewed by the Committee will disappear as independent entities once the reorganization takes legal effect. Specifically:

- the new Department of Industry (now known as Industry Canada) will include the former Departments of Communications and of Industry, Science and Technology (which were assessed by the Committee), as well as most of the former Department of Consumer and Corporate Affairs and the former Investment Canada.
- the new Department of Natural Resources will include the former Departments of Forestry and of Energy, Mines and Resources (both of which were assessed by the Committee).
- the new Department of Health excludes the social welfare programs provided by the former Department of National Health and Welfare (assessed by the Committee); social programs are now provided through the new Department of Human Resources.

The announced reorganization has minimal effect on the relevance of the Committee's work. The new departments will take some time to develop their new identities and to integrate S&T programming; an assessment of the new organizational structures would not be meaningful for some time. However, the Committee's assessments of the programming of the former organizations might be instructive in establishing the roles and goals of the new structures.

Application of the Principles

The Committee applied its principles to the 19 organizations. Members met with Ministers and/or officials of most of the organizations. Organizations to be interviewed

received information on the principles to be applied by the Committee in advance of the meeting.

The Committee tested its interview methods and briefing documents with the (former) Departments of Communications and Forestry. As a result, members agreed to simplified documentation provided to departments and focused questioning on how departments set their own priorities. The modified methods were applied to the 16 other organizations on the interview list.

Following the interviews and a review of published materials about the organizations, members presented their findings, in draft form, to representatives of the 19 organizations for their comment. This report incorporates many of the comments received from departments and agencies.

Findings

Managers direct resources to their priorities. Resources available to managers include money, personnel and managerial attention.

Authentic priorities have a hold both on the budgets and on the attention of managers. One or the other is rarely sufficient. The most proficient management cannot function without sufficient resources. Unmanaged resources are rarely well spent.

1.

Gauged by the allocation of resources, science and technology are priorities of the federal government.

- i) *Federal S&T spending has increased 84 percent in absolute terms since 1982-83. Spending growth has outpaced that of the Consumer Price Index, which means that S&T spending has grown in real terms. (Exhibit Three)*

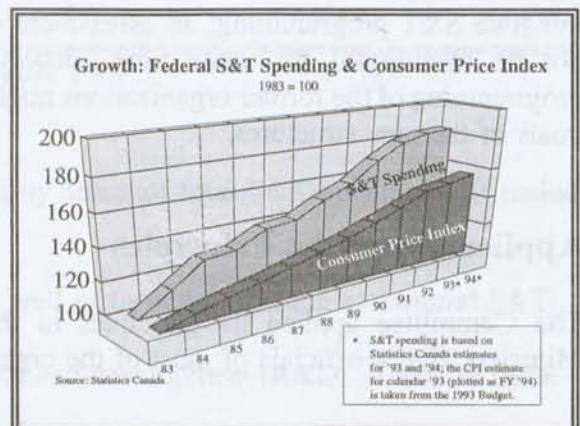


Exhibit Three

- ii) *The growth of S&T spending has been greater than or equal to the growth in spending of most categories of federal program spending. S&T spending appears to have a priority. (Exhibit Four)*

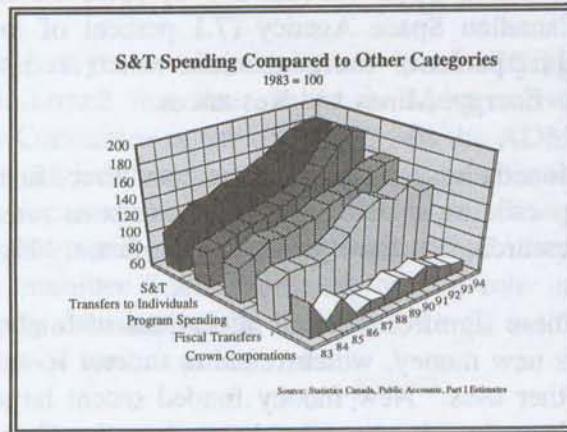


Exhibit Four

2.

The Committee could find no evidence that the government has any explicit rationale for the distribution of S&T spending among departments.

Assuming that the relative distribution of funds is an expression of relative S&T priority, Environment Canada is the government's top S&T priority, followed by the National Research Council, the Natural Sciences and Engineering Research Council, the Canadian Space Agency and Energy, Mines and Resources Canada. Exhibit Two shows the ranking, by current spending, among the 19 organizations assessed by the Committee.

No information obtained by the Committee explained why these individual budgets were at their particular levels, or provided a rationale for why the budget of one organization was larger or smaller than another. For example, the Committee saw no evidence that a clear policy objective was being served by allocating 6.2 percent of federal S&T financial resources to the Department of Agriculture and 1.7 percent to the Department of Forestry. Similarly, there was no apparent strategy behind the allocation of 6.3 percent of resources to Energy, Mines and Resources and 1.2 percent to the Department of Communications.

One explanation offered by some federal officials is that certain budgets have benefited by historical incrementalism, a hypothesis which suggests that organizations with the greater longevity have the larger budgets. Once an organization has a large budget to be directly administered, it is usually assigned a senior Minister, who has developed

experience and capacity in maintaining or increasing budget allocations. This argument has some appeal but does not explain, for example, the rapid growth of the budgets of the Canadian Space Agency (7.1 percent of total federal S&T) or Environment Canada (11.2 percent) — organizations which are much younger than, for example, Agriculture or Energy, Mines and Resources.

Nonetheless, the government does direct funds into specific areas of S&T activity or to specific organizations. There have been some expenditures, such as those for university research, that have grown at significantly higher rates than overall funding for S&T.

These significant recent allocations of funds, however, have been with funds identified as new money, which refers to federal spending not already disbursed or committed to other uses. New money funded recent large increases in the budgets of the Granting Councils. It also was directed to the Green Plan, led by Environment Canada. The Canada Scholarships Program as well as the Networks of Centres of Excellence Program were also funded by new resources.

However, the Committee did not see evidence of reasoned reallocations among the established S&T budgets of departments and agencies. De facto, reallocations do take place. Since 1982-83, the S&T expenditures of the National Research Council have declined from a 10.9 percent share to a 8.6 percent share of total federal S&T spending. Those of the Department of Communications have been reduced from a 3.2 percent to a 1 percent share. However, these reallocations appear to be the result of other factors than a conscious determination of how overall federal S&T spending should be allocated in accordance with a government strategy.

3.

The government has organized itself to manage horizontal issues in S&T, but has not been successful in finding a method to select priorities among areas of S&T, S&T programs or S&T organizations.

More than two decades ago, the government began to organize itself to manage S&T (with the establishment of the Ministry of State for Science and Technology). There have been several organizational and operational structures since then, but no substantive progress in identifying the S&T priorities of the federal government.

The current mechanism for coordination of federal S&T activities is the Interdepartmental Steering Committee on the Management of S&T, which has representation at the level of

Assistant Deputy Minister (ADM). The ADM Committee has concerned itself with such horizontal issues as extramural performance, technology centres and intellectual property.

The Interdepartmental Steering Committee has yet to show progress in identifying priorities, although the Committee was informed that the subject is under active consideration. The NABST S&T Priorities Committee is not optimistic that the ADM Committee, which arrives at its decisions or advice through consensus, will be able to make recommendations on priorities among departments or agencies. To do so, one or more ADMs would be required to concede that some of the S&T activities which they supervise are not priorities. The ADM Committee could, however, have a role in developing the factual basis on which priority decisions could be made as well as in determining the advantages and disadvantages of various policy options.

4.

Some federal organizations do not consider S&T to be a distinct element of their activities, one that needs to be managed as such.

Federal S&T activities are catalogued through a survey conducted by Statistics Canada. Compared to the rigour with which a federal organization provides financial data to the Treasury Board, participation in the survey does not appear to be viewed as an important obligation. Nor is the survey data used within federal organizations to assist in management of their S&T investment. Indeed, on a few occasions, the Committee needed to explain to officials of an organization how and where it had obtained its data on that organization's S&T spending.

The current description of S&T by Statistics Canada is based on an international definition of R&D, and a Canadian definition of RSA. It is reasonable to inquire whether this definition leads to a description of federal S&T activities that require strategic management or prioritization. For example, current definitions classify economic analysis within the Department of Finance or S&T policy development within the Department of Industry as S&T activities. Some might question this classification. Current definitions also classify as S&T the Canadian-funded R&D conducted by or for developing countries. S&T in this area is not easily compared to domestic S&T for domestic purposes but it represents a significant proportion (roughly 5 percent) of the federal S&T investment. In assessing the S&T expenditures of the Canadian International Development Agency and the International Development Research Centre, the Committee found that its principles were applicable and relevant. For the purposes of this report, the Committee accepted the Statistics Canada definition as it is in current (if not universal) use.

Some federal organizations do not recognize S&T as a distinct element of their organizations, even though they are major funders or performers. In the Committee's view, that approach may reduce the effectiveness of the organization and possibly prevent attainment of its objectives. Recognition of S&T as a distinct element does not necessitate reorganization but, as will be discussed further, it does require that S&T be distinguished within the organization and that S&T be consciously managed in support of departmental objectives.

S&T activity is not an end in itself. It is a means to achieve particular objectives such as the advancement of knowledge, the accomplishment of departmental missions, competitiveness, and so on. There is thus a natural and reasonable tendency to view S&T simply as tools to be applied to achieve a purpose.

However, the tools themselves, their condition and the way they are applied, can be critical to the attainment of objectives. The government recognizes this principle in other policy areas. For example, although contracts for services may be used as a tool to achieve departmental objectives, the federal government has adopted uniform contracting policies to ensure that the government achieves best value for money and that the process of acquiring goods and services both is, and is perceived to be, fair and open. In this case, a government-wide objective is determined by Cabinet and implemented by individual departments. Similarly, although federal personnel are among the instruments by which departmental objectives are achieved, Deputy Ministers in each department are accountable for their adherence to government-wide policies respecting the advancement of women and employment equity.

If S&T are recognized as tools vital to achieving certain government objectives, then it is prudent to care for those tools and to ensure they are applied correctly. As a priority, federal S&T activity should be considered as a domain in its own right, something that is managed directly. Determination of spending priorities is an integral part of management.

Several federal organizations have recognized S&T as a distinct element and have developed particular policies or practices to manage S&T. In general, the Committee found that these organizations had more highly developed systems for determining S&T priorities within their own programming.

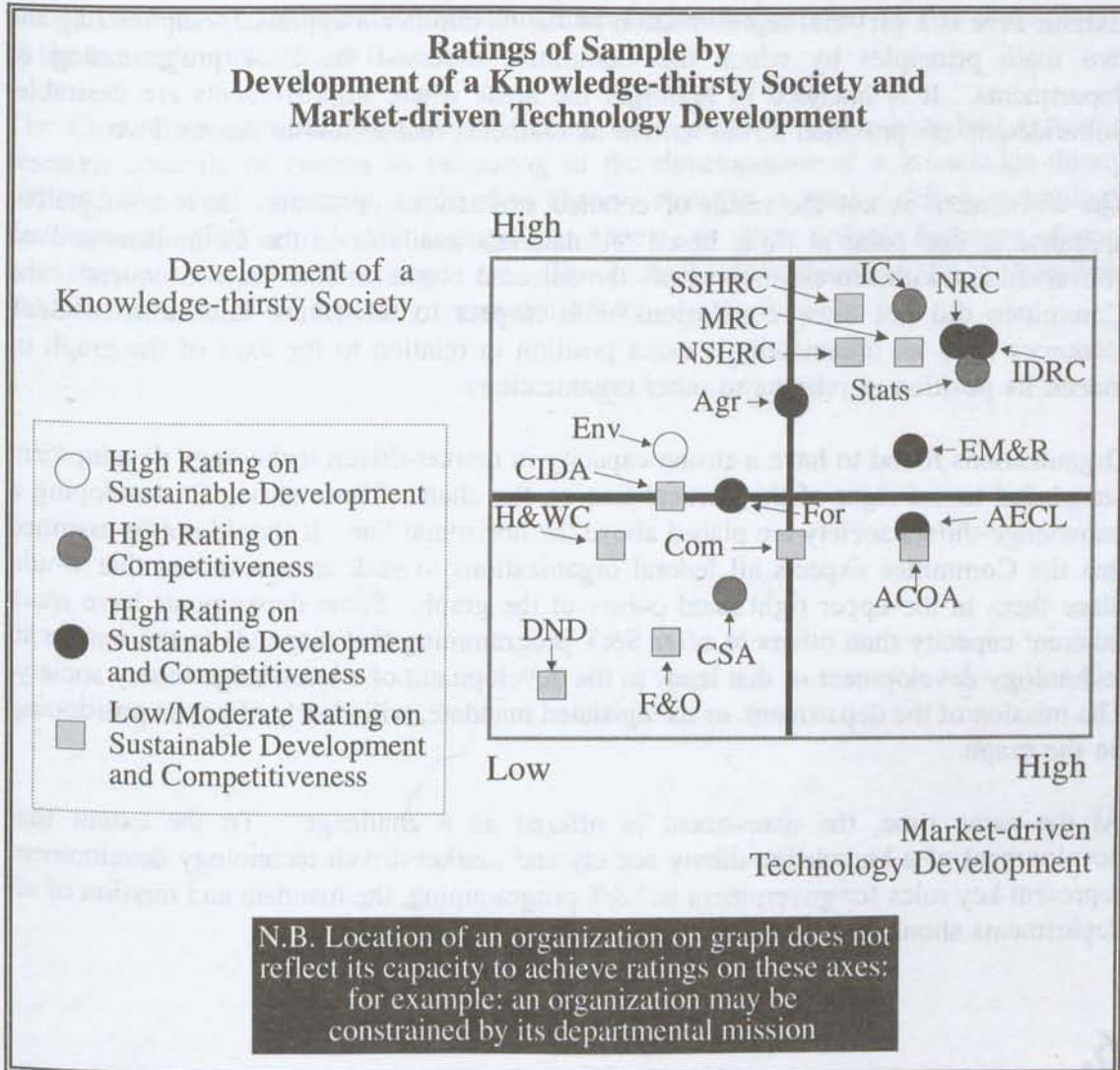


Exhibit Five

5.

The comparative assessment of selected organizations, displayed as Exhibit Five, should be understood, first and foremost, as the Committee's identification of fields in which the organization could improve. Suggestions follow in the written text applying to each organization, presented as Annex Two.

Exhibit Five is a pictorial representation of the Committee's appraisal, emphasizing the two main principles by which the Committee assessed the S&T programming of departments. It is intended to highlight the areas where improvements are desirable. Some details are provided in the written assessments that follow in Annex Two.

The assessment is not the result of detailed evaluations or audits. It is a subjective appraisal at one point in time, based on materials available to the Committee and on conversations with representatives of the selected organizations. In consequence, the Committee did not draw conclusions with respect to the future allocation of S&T resources from an organization's exact position in relation to the axes of the graph or indeed its position in relation to other organizations.

Organizations found to have a strong capacity in market-driven technology development are placed to the right of the vertical line on the chart. Those strong in developing a knowledge-thirsty society are placed above the horizontal line. It should not be assumed that the Committee expects all federal organizations to seek an assessment that would place them in the upper right hand corner of the graph. Some departments have more inherent capacity than others to offer S&T programming that responds to the market in technology development or that leads to the development of a knowledge-thirsty society. The mission of the department, or its legislated mandate, will clearly affect its positioning on the graph.

At the same time, the assessment is offered as a challenge. To the extent that development of a knowledge-thirsty society and market-driven technology development represent key roles for government in S&T programming, the mandate and mission of all departments should reflect them.

6.

Organizations positioned at arms-length to the government were strong in both key criteria.

Of the 19 organizations examined by the Committee, eight were found to be strong in both development of a knowledge-thirsty society and market-driven technology development. On the Chart presented as Exhibit Five, those organizations are situated in the top right hand corner.

The Committee examined five organizations managed at arms-length from the government: the International Development Research Centre, the Medical Research Council, the National Research Council, the Natural Sciences and Engineering Research

Council and the Social Sciences and Humanities Research Council. All five were placed in the top right quadrant of the chart.

The Committee considers this observation to be significant. Members had expected research councils or centres to be strong in the development of a knowledge-thirsty society. We were agreeably surprised to observe strength in market-driven technology development. The arms-length arrangement appears to allow a sharp focus on clients: who they are and what their needs are. The councils may, therefore, be an excellent vehicle for more of the federal government's S&T.

Conclusions

The mandate of the Committee calls for:

- development of a simple method for setting the science and technology priorities of the federal government; and
- application of that method to a substantial portion of federal S&T spending, based on a clear policy framework.

The conclusions of the Committee concern substance and structure as well as process.

Substance

1.

Government should recognize and manage S&T as a distinct strategic asset; as a first step, S&T should be catalogued according to consistent principles.

There is validity to the view that federal S&T is a means by which other objectives are achieved. However, the Committee does not accept the further argument that S&T therefore requires no special management attention. As a government priority, federal S&T should be managed as such. Determination of spending priorities is an integral part of the management of federal S&T spending. As a national strategic investment, S&T requires high level strategic planning. Other government-wide priorities, such as open contracting policies and employment equity, are managed as distinct areas. Deputy Ministers are held accountable for adherence to these policies at the departmental level. This should be required for the management of S&T.

Disciplined pursuit of particular objectives for federal S&T programming presupposes at the outset that S&T programming can be distinguished from other programming. It also presupposes that management measures can be applied to S&T programming as an entity. Neither supposition can currently be accepted throughout the federal government.

Organizations which cannot identify their S&T activities can hardly improve their management of them. Parliament, Cabinet, central agencies or the general public cannot assess the quality of government S&T management if there is no consistent way of perceiving it within government. Accurate and consistent data and reporting are essential to management of S&T within and among departments.

Management of S&T as a distinct entity will require a more precise and trustworthy definition of S&T. The need for a formal budgetary 'envelope' would depend on the degree of central budgetary control desired.

Heads of some departments and agencies will require a more clear definition of the S&T activities taking place within their organizations. The Committee is not convinced that it would always be necessary or appropriate to reorganize so that all S&T activities are together. In other departments and agencies, managers already have a clear picture of S&T activities and their goals. The Committee notes that two organizations, Health Canada and the Canadian International Development Agency, have recently adjusted their organizational structures to enable more direct management of S&T activities.

2.

There should be two main objectives for the S&T programming of the federal government:

- *development of a knowledge-thirsty society; and*
- *market-driven technology development.*

In presenting this conclusion, the Committee is aware that many federal organizations have specific obligations, sometimes of a legislative nature, to provide certain services. These obligations are usually presented as the 'mission' of the organization. An organization's mission may limit its capacity to engage in market-driven technology development or to support the development of a knowledge-thirsty society. Nonetheless, even within the requirements of a mission, the Committee believes that all federal organizations can make some progress towards the primary goals of federal S&T programming.

This conclusion gives particular prominence to only two of the original four principles proposed by the Committee. The following text discusses the shift in emphasis.

As previously noted, future competitive societies will be knowledge-thirsty. Hence, development of a knowledge-thirsty society is understood as a necessary (but not sufficient) condition for future prosperity. Since it is a precondition for future prosperity, the Committee considers the principle of development of a knowledge-thirsty society to be logically prior to the principle of competitiveness itself. For similar reasons, the Committee concludes that development of a knowledge-thirsty society is a necessary condition to pursuit of the principle of sustainable development. The interest of a society in adopting the principles of sustainable development results from the acquisition and

appreciation of knowledge about the impacts of human behaviour upon the planet. The capability for an industrial society to adjust to sustainable practices is largely dependent upon knowledge about the consequences of its behaviour.

The role for government in developing a knowledge-thirsty society includes a number of activities. Government has a role in **supporting the creation of new knowledge**. Resource limitations, likely to prevail for the foreseeable future, should lead the government to limit its support to the creation of new knowledge in scientific or social areas that are likely to be of use to society. Another major element of the government's role is in the **dissemination of information** useful for business or educational activities. More specifically, government has a role in **prospecting**, world-wide, for scientific discoveries and new technologies and processes. It has a role in **evaluating** these, and in then **distributing** the information to businesses in the private sector, educators and scientific researchers. Associated activities include the collection and preservation of information.

To ensure that the information is useful to the diverse needs of society, government should rely on partnerships, alliances, secondments, interchanges and joint funding with private firms, educational institutions, provincial governments and foreign jurisdictions. External advisory groups and peer review activities can also ensure that the work is of relevance and quality.

Building the infrastructure for a knowledge-based economy involves more than the collection of information and the performance of research. Other important activities include education, training, and the development of a science culture.

Another major role for government is in encouraging market-driven technology development. The Committee believes that market-driven technology development is another precondition for competitiveness and prosperity. In a way, the principle expresses the preferred method for the dissemination and application of the knowledge upon which prosperity depends. The focus of technological development should be limited to market-driven development, as only limited resources are available to support S&T. Market-driven development is the more likely to produce results which will be of benefit to society as a whole. Development of technology in response to the needs of the market presupposes: client identification; awareness of client needs; participation by clients; and knowledge of the global competitive situation of the industry. Market-driven technologies will often result in the creation of linkages to private firms as well as contributions from private firms to the costs of commercialization.

In reviewing the S&T programming of the organizations in its sample, the S&T Priorities Committee found areas where programming could better respond to the principles

proposed by the Committee. These areas for potential improvement have been identified in the assessments. It is the Committee's view that such improvements, once made, would lead to programming more in touch with its clientele and better able to serve Canadian needs.

Process

3.

Decisions are required on the allocation of federal S&T spending.

Government has no grounds for concluding that the current distribution of S&T spending among federal organizations reflects the government's strategic objectives for the country generally or for its S&T investment in particular. Notwithstanding the priority status given to S&T within the federal budget, the government commitment to S&T is incomplete in the absence of efforts to direct and allocate the budget to priority areas. Decisions concerning the allocation of new resources are necessary but not sufficient. The greater portion of S&T spending is long established, much of it growing through incremental additions to budgets. Incrementalism could well be a valid approach to the management of S&T budgets, but there has been no considered decision that that should be the approach.

The work of this Committee provides the opportunity for government to re-think its objectives in funding S&T programming, to encourage federal organizations to achieve these objectives through modifications to programming and to reallocate its resources to those organizations which can best achieve government objectives for S&T.

Recommendations

1.

The government should require: that all departments and agencies manage their S&T activities as a distinct strategic asset; that central agencies monitor the total S&T investment as an asset portfolio.

Central agency managers should determine what level of data is required to obtain a clear picture of S&T activities across government and arrange for its collection. Managers of individual organizations should be held accountable for implementation of a management strategy for their S&T programming that meets the objectives of the government.

2.

The government should advise all departments and agencies that the two main objectives for the S&T programming of the federal government are: development of a knowledge-thirsty society; and market-driven technology development.

For the Committee, these objectives represent the most appropriate S&T priorities for the government. Federal organizations should ensure that their S&T programming supports these objectives.

These priorities are horizontal — they apply to all federal organizations — thus they are not of immediate application in determining how funds should be allocated across organizations. However, in the view of the Committee the first step is for all government organizations to pursue a common set of objectives; any reallocation of funds among organizations would flow from that process.

The Committee found that organizations established at arms-length to the government were more effective in achieving the main objectives. It would be appropriate for government to review that finding and consider whether and/or how federal S&T could be reorganized accordingly.

3.

The government should require that reports on the identification of S&T as a strategic asset and on the application of the two key priorities be prepared for review by six months after this Committee Report is made available to senior managers.

External monitoring of the application of the first two recommendations will encourage their implementation within federal organizations. The recommendations represent more than a passing management fad, something to be accommodated temporarily. The Committee is seeking a structural change in the way that managers view and supervise their S&T investments.

The Committee suggests that the review be done by NABST, because the Board is external, independent and focused on S&T.

4.

The government should establish a system for priority-setting for S&T within and among federal organizations. That system should be announced, or reviewed with NABST, within six months after the Committee Report is made available to senior managers.

Priority-setting exercises are rarely uncomplicated and painless. Controversy is an inherent characteristic of any mechanism to accomplish that task. Challenged with the possibility of setting priorities, there is no reason to expect that the federal government would be exempt from such stresses.

Nonetheless, after two decades of considering the question, the federal government still lacks the capacity to determine whether one S&T activity better meets government objectives than another and to reallocate resources accordingly. It cannot assess the comparative return on its S&T investments; nor can it take the first steps toward investing for maximum return. Further, in the future fiscal constraints may well demand re-allocations of S&T resources. In the absence of a system or specific direction for determining S&T priorities, S&T reallocations would of necessity be arbitrary.

The need to set priorities has been recognized, and acted upon, in other jurisdictions. The Government of the United States has recently established a more effective system for setting S&T priorities, with the Office of Science and Technology Policy and the Office

of Management and Budget taking lead roles. The Government of the United Kingdom has recently released a White Paper statement of proposed policy outlining a system for setting priorities, based on the advice of an external S&T advisory council.

The Committee offers to the Government of Canada the following elements of a priority-setting system for consideration.

- i) *Cabinet, or one of its Committees, should review, and approve or modify, S&T activities (and their associated resources) of departments and agencies at least once every five years, preferably every three years.*
- ii) *The review of S&T priorities and any recommendations for changes could be presented to Cabinet in a joint submission signed by the Minister of Industry (on the advice of the Secretary of State (Science, Research and Development)) and the President of the Treasury Board. [This is one model; others may also be workable.]*
- iii) *Ministers who present advice to Cabinet on S&T priorities should base their recommendations on advice received from a group (or groups) external to government as well as advice received from science-based organizations within the federal government. Such advice would include, but not be limited to, international benchmarking.*
- iv) *There should be general guidance, at the beginning of the process, on overall government objectives or principles (such as development of a knowledge-thirsty society) to the external advisors and to federal science-based organizations.*

For Cabinet to review S&T Priorities, one or more Ministers must present proposals and a supporting analysis. The Committee recommends the proposals be presented by a Minister who is particularly knowledgeable about federal S&T activities (the Minister of Industry, assisted by the Secretary of State (Science, Research and Development)), but that the neutrality of the proposal (with respect to perceived conflict of interest with the spending of the Industry portfolio) be verified by the head of a central agency (the President of the Treasury Board). These would be new functions for both Ministers and specific instructions from the Prime Minister may be required.

The Committee also considers it important that the advice of external advisors be sought in setting S&T priorities. Such advice can transcend the 'portfolio preferences' of advice received from federal organizations.

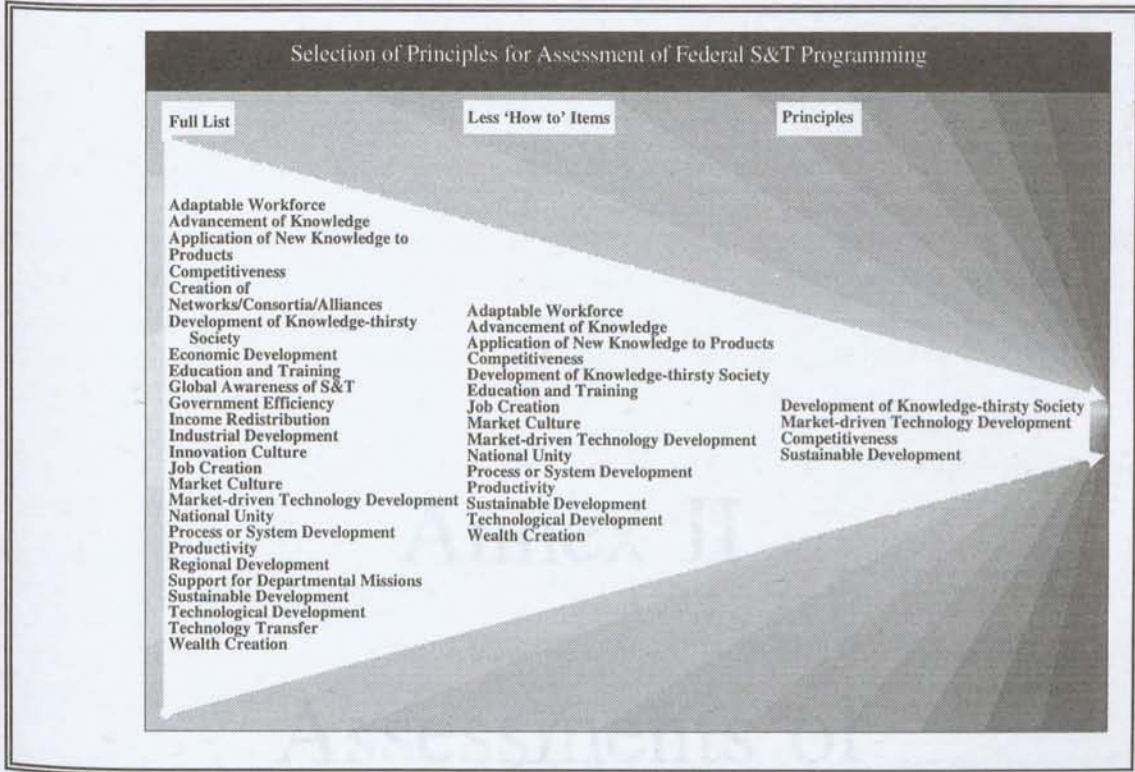
As noted above, these recommendations represent general suggestions from the Committee. Experts on government machinery, organization and operations may well be able to develop more effective proposals. The Committee encourages them to do so.

However, two decades' consideration of priorities is long enough. The government should make a decision about a system for establishing priorities and then implement it.

Annex I

Exhibit Showing

Development of the Principles



Assessments of Organizations in the Sample

Annex II

Assessments of Organizations in the Sample

AGRICULTURE CANADA

1. Development of a Knowledge-thirsty Society

Dissemination of knowledge has been a major purpose and role of the Department of Agriculture from its establishment to the present day. Agricultural extension services are still considered as a model for the diffusion of knowledge. This diffusion would be more efficient and probably less expensive, however, if there were better cohesion between federal and provincial activities in extension services.

The consultative processes of the Canadian Agricultural Services Coordinating Committee and the Canadian Agricultural Research Council (CASCC/CARC) also aid in the development of a knowledge-thirsty society. The Committee expressed two concerns about departmental performance in this area: first, that the consultative process does not focus on major food producers; and second, that the large number of small agricultural research stations may be unnecessary, ineffective and uneconomic given current communications and transportation networks.

The Committee suggests the department undertake the following actions to improve its performance under this heading:

- make adjustments to the consultative process to include major food processors and producers;
- continue its review of its many research stations, with a view to assessing the desirability of reducing their number and refocussing the work of the remainder; and
- encourage federal and provincial ministers to build cooperative farm extension programs.

2. Market-driven Technology Development

The Department is engaged in an effort to revise its policies so that research is more responsive to the needs of the private sector; this is positive. Agriculture Canada has a long history of consultation with those external to government. However, Members expressed some doubts whether the department was hearing from the full range of potential beneficiaries of agricultural R&D. Consultations appeared to include those who currently perform agricultural research, but not enough of those who could benefit from it. To achieve the full benefits of the consultative process, the department must continue

to respond to the recommendations it receives; the response could be adoption of the recommendations, modification of them, or an explanation as to why they cannot be applied.

The Committee also found that the Research Branch of Agriculture Canada has an unfocused definition of its clients.

The Committee suggests that the department:

- broaden the scope of those with whom it consults;
- ensure that the consultative process includes a response from the department; and
- more clearly focus its definition of clients on agricultural producers (the full range of that broad spectrum) and processors.

3. Competitiveness

The agri-food industry is a significant contributor to the Canadian economy and agricultural exports are an important element of our merchandise trade surplus. The principal objective of the Research Branch of the Department is the long-term competitiveness of the agri-food industry and so research programs are directed to that end. The Committee also found that the food inspection activities of the department were an important element supporting the Canadian standard of living.

In developing its market orientation in the performance of research, the department should be careful to avoid unfair competition with private sector suppliers of agricultural knowledge. The objective of the Research Branch should be to complement the private sector, not to compete with it. Where research overlaps, the department should ensure that its commercial services are offered at comparable market prices. The Committee believes that more R&D should be directed to exploiting opportunities for adding value to agricultural products. The current organization of government which places responsibility for manufacturing and processing in ISTC — quite separate from Agriculture — has not been effective in enhancing value-added initiatives by this department.* This difficulty, shared by other departments, is discussed in the Conclusions section of this Report.

* The government has taken steps which may address this issue, by including agri-food with the new Department of Agriculture and Agri-Food

4. Sustainable Development

The concept of sustainable development is at the core of the Department's purpose, although the manner in which the objective is pursued has varied. Sustainable development is now one of the department's main priorities. Several programs support the objective.

ATLANTIC CANADA OPPORTUNITIES AGENCY

1. Development of a Knowledge-thirsty Society

Although human resource development is one of the stated themes of ACOA programming, the Committee could not find persuasive evidence that the theme guides programming. The Agency's sponsorship of the Nova Scotia Technology Network is positive. However, the Committee believes that ACOA should also concern itself with the use of the network and the content of the information that flows through it; the infrastructure itself is of less importance than the use to which it will be put.

The Committee believes that the Agency's programming should be oriented towards assisting its clientele (firms within the region) to identify, gain access to, and apply technology to business operations. That process may require considerable education of firms at the front end. However, development of a more knowledge-intensive economy is a precondition for sustainable regional development.

2. Market-driven Technology Development

Much of ACOA's programming responds to the market signals of its clientele: firms within the region. As many firms within the region are not yet innovation capable, however, programs to support technological innovation are limited in their reach. The Committee was pleased to note that ACOA does not take a dirigiste approach in its programming; the decisions of private markets guide the allocation of funds.

3. Competitiveness

For ACOA, competitiveness is a key objective. The Agency recognizes the role of R&D and skills development in achieving this objective. This is a welcome evolution from regional development practices of the past.

Although the right policy statements appear to be in place, S&T spending of the Agency is very small in relation to its total disbursements. The Committee found that, overall, ACOA still has too strong an orientation towards support for real estate, equipment and infrastructure: what the Committee considers to be 'bricks and mortar'.

In the Committee's view, competitiveness in the region is more likely to result from soft (intangible) investments by government and industry over the long term. Such investments would include training and education of managers and the workforce.

4. Sustainable Development

ACOA does not include sustainable development in its objectives or its programming. However, the Agency participates in cooperation agreements with provincial governments to support sustainable development objectives; these seek to encourage the adoption of sustainable development principles within the private sector.

ATOMIC ENERGY OF CANADA LIMITED

1. Development of a Knowledge-thirsty Society

The primary focus of the corporation is commercial. As such, it is not in the primary interest of AECL to adopt a government S&T objective. The core R&D objective of AECL is, quite appropriately, CANDU development. Research partnerships with Canadian and foreign organizations have as their primary purpose the development of more competitive products. Nonetheless, the Committee observed a number of S&T activities which have a strong orientation to the dissemination of knowledge to the public, and to the development of a science culture. These include a major publications program, a speakers bureau and the management of education programs.

2. Market-driven Technology Development

The corporation has a two main objectives. One objective is that of a commercial enterprise, dedicated to the engineering, project management and marketing of reactors and nuclear technologies. The other is that of research operation, which provides the technology base for reactor technologies and, as well, acts as Canada's *de facto* National Nuclear Laboratory. Over the last ten years, there has been a corporate cultural revolution within AECL. Now, technology development is strongly market-focused. With respect to reactor technologies, AECL keeps in close touch with its actual and potential

clients and endeavours to gain their participation in R&D planning and execution. The Committee has some doubts about the size of future markets for reactor technologies.

3. Competitiveness

Reactor sales can make a strong impact upon the balance of payments, in the advanced technology category where Canada's performance tends to be weak. Activities of the nuclear industry in Canada make a material contribution to national prosperity; some nuclear technologies contribute directly to an improved quality of life.

4. Sustainable Development

AECL makes the case that nuclear power supports improved environmental conditions, by displacing hydrocarbon-based power sources. The Corporation's work on disposal technologies is indicative of awareness and concern about the environmental sustainability of its own activities. AECL is not specifically organized around sustainable development as an issue.

CANADIAN INTERNATIONAL DEVELOPMENT AGENCY

1. Development of a Knowledge-thirsty Society

CIDA is aware of the importance of knowledge to economic development. A substantial proportion of the organization's national initiatives are directed towards human resources development. The Agency supports training and education programs in developing countries and provides training for foreign students within Canada. Knowledge and technologies are transferred through technical assistance programs. Within Canada, CIDA supports some partnership and education programs to develop public awareness of development issues.

2. Market-driven Technology Development

Although CIDA has an industrial cooperation program, the Committee found little emphasis on the market and the private sector as the engine for technology development.

3. Competitiveness

Application of this principle was problematical in this case, as CIDA endeavours to achieve the competitiveness of countries other than Canada. With that accepted, Members observed that CIDA has some programs which support the development of competitive

firms among their clientele. The Committee found that CIDA would have a stronger impact in building client country competitiveness if they were to build very strong private sector bridges between client countries and Canada.

4. Sustainable Development

The Agency has a sophisticated understanding of the concept of Sustainable Development, and assesses development programs accordingly. CIDA also funds a number of programs which specifically address environmental issues. Once again, the Committee found difficulties in reviewing programming under this heading, as the primary beneficiaries are intended to be non-Canadians.

CANADIAN SPACE AGENCY

1. Development of a Knowledge-thirsty Society

The Committee recognizes that the Canadian space program has enormous potential to generate new knowledge about earth and space, knowledge that could have great use both for science and business. The space program may also have an inspirational influence on the learning and career decisions of Canadian youth.

Members believe that the CSA could do a great deal more to disseminate knowledge and cultivate interest in space and earth sciences as well as in the use of such knowledge for wealth generation. The Committee suggests that the Agency broaden its perspective on technologies for use in space beyond the aerospace, robotics and electronics sectors; there may also be opportunities, in partnership with other federal departments, in agricultural, environmental and telecommunications technologies, to which Canadian researchers could contribute.

2. Market-driven Technology Development

The Agency undertakes a major consultative process prior to developing its Long Term Space Plans. The process provides an opportunity for the CSA to respond to external demands, including those from the science community, industry, governments and the general public. As most clients are specialized and not driven by national or international free (i.e., non-government) market forces, technology development is not strongly connected to the marketplace.

The Committee believes that a long-term space plan should include plans for less reliance on government and more upon the private sector. Such an approach requires examination of opportunities for the Canadian private sector. Again, sectors other than aerospace and electronics should be considered.

3. Competitiveness

Space and related technologies account for a relatively small proportion of merchandise trade, but it is an area of rapid growth. In part due to government-sponsored development projects, a few Canadian companies have established worldwide reputations for quality and have established product niches, in such areas as robotics, multiplexers and synthetic aperture radar. Research funded by the Canadian Space Agency (CSA) results in the development of the technologies of the future. A higher rating was not assigned due to the limited size of the domestic and external market and the uncertainties of successful spin-offs to larger volume commercial uses.

4. Sustainable Development

Technologies developed for the space program (such as WINDII) will assist in the understanding of global change and the forces that bring it about. Services such as GEOSCOPE will also contribute to that understanding. Radarsat will contribute directly to the information base required to assess environmental changes. However, the CSA does not have any specific programs or program objectives in support of sustainable development.

COMMUNICATIONS CANADA

1. Development of a Knowledge-thirsty Society

A communications department could have a major role in the establishment of a knowledge-thirsty society by facilitating the provision and management of the infrastructure for more efficient distribution of information. This department has made some contributions toward that end. However, it could be argued that communications regulation impedes the flow of information.

There are significant opportunities for the department in the development of informatics and electronic information. Some such areas are already being exploited: for example in the department's research on coding and modulation. However, the Committee believes the department should focus more on supporting the development of software and

telecommunications-related intellectual property than on the bricks and mortar of physical telecommunications or electronic infrastructure.

2. Market-driven Technology Development

The department receives advice from external advisory boards, but that advice has often not had a significant impact on the direction of the department's S&T activities. Technologies such as SHARP (Stationary High Altitude Relay Platform) were not developed in response to market demand. The consultative process cannot achieve its full benefits unless the department has some obligation to respond to the advice or recommendations it receives. The response could be adoption of the recommendations, modification of them, or an explanation as to why they cannot be applied. Communications Canada has reconfigured its advisory boards in order to be more responsive.

The department's assumption that government must lead in the development of a national telecommunications infrastructure would appear to pre-empt the creation of such by private capital.** The Committee acknowledges that some of the department's activities result from explicit government direction (such as the provision of communications services to remote areas); these are by definition independent of market forces.

3. Competitiveness

Communications and informatics are technologies of rapidly growing importance to our competitiveness. They are important in their own right; a good communications infrastructure can be as important as conventional infrastructure, such as roads, perhaps more so. The technologies are also important for their use in all sectors of the economy. Communications systems are the physical underpinning of a knowledge-based economy. The communications and informatics industries in Canada have a reputation for strong performance in R&D.

The department has negotiated a number of bilateral agreements with individual firms and supports firms' use of the Industrial Research Assistance Program of the National Research Council. However, in the Committee's view, the primary focus of Communications Canada is on large scale projects and public infrastructure.

** The non-culture parts of the former Department of Communications are now included within Industry Canada.

The Committee recommends that the department review the emphasis of its programming, to ascertain whether a better balance could be struck between soft and hard investments.

4. Sustainable Development

The Committee did not note any specific activities by the department in support of sustainable development. Departmental officials argue that activities to support efficient use of the transmission spectrum concern the sustainable development of a finite resource.

ENERGY, MINES AND RESOURCES CANADA

1. Development of a Knowledge-thirsty Society

The department considers information and technology as its principal products and has in place a large number of systems and methods to ensure that information is diffused. The Committee also noted a significant awareness of international developments and opportunities.

2. Market-driven Technology Development

EM&R has an active system for keeping in touch with its external clients, through various advisory councils, conferences and forums. The department deliberately reallocates funds in response to changing priorities. The Committee found that EM&R has a strong focus on external clients.

The advisory council system can be made or kept effective by ensuring that the department responds to the advice received. The response could be adoption of the recommendations, modification of them, or an explanation as to why they cannot be applied. The Committee suggests the department ensure that its mechanisms for consultation include this important element.

3. Competitiveness

Exports of metals, minerals, oil and gas make a major contribution to our trade position and, despite changes in the nature of world trade, are likely to continue to do so for the foreseeable future. Although the industries are often perceived as relics from our past, the amount of value-added per unit labour cost exceeds that of many manufacturing

sectors. Related, supporting exploration industries, such as the geophysical and remote sensing industries, have as yet a relatively small impact on trade; however, Canadian firms are in a very strong competitive position.

S&T within the department highlights the most efficient (and safe) methods for exploitation of the raw resource. It also focuses on provision of the data infrastructure for metal, mineral and hydrocarbon resource industries. Although some argue that EM&R should invest more of its S&T effort in the development of value-added applications for raw resources, the organization of government places such downstream activities within the purview of ISTC. Nonetheless, at the request of its clients the Department has broadened its research focus to include product development.

4. Sustainable Development

Many of the S&T activities within the department are directed to providing the basic survey data required for an understanding of the state of the environment. In addition, research facilities such as CANMET address important, practical issues such as recycling and the management of mine wastes. EM&R participates in the Green Plan and has developed specific projects.

ENVIRONMENT CANADA

1. Development of a Knowledge-thirsty Society

The department disseminates environmental information widely. Research is published in refereed scientific literature. Many of the research staff teach in post-secondary institutions.

The Committee believes that the department could build greater public interest in its work if it had more of an outreach approach, especially in providing more opportunities for personnel exchange between the department and the business and educational sectors. Considerably more could be done in all areas to develop interest in and knowledge about environmental problems, solutions and opportunities.

2. Market-driven Technology Development

A large proportion of the department's S&T activities are undertaken to support its mandate, such as forecasting the weather or monitoring toxic chemicals. This factor

places limitations on the capacity of the department to respond to market needs. Some technologies are offered for commercialization, but this is not a major focus for the department. Where the department has more flexibility in developing commercial technologies, it appears willing to innovate: the Wastewater Technology Centre, for example, is established as a Government-Owned/Contractor Operated facility for the primary purpose of improving technology transfer from government laboratories.

In keeping with the observations that follow under the heading of Competitiveness, the Committee suggests that the department develop advisory councils for major industry sectors, with participation from private industry. At the start, these advisory councils could work to reduce the unnecessary and unproductive opposition between industrial and environmental concerns. Eventually the advisory councils can become a forum for identifying industrial opportunities in environmental technologies or environmental management and regulation. The Department of the Environment should work closely with ISTC in developing its councils, and continue a close connection in identifying industrial opportunities.

3. Competitiveness

The Committee considers acceptable environmental conditions to be an element of the high standard of living that should be the hallmark of a competitive country. Environment Canada has a role in achieving that objective. However, the Committee did not perceive a consistent awareness of the potential alliance between competitiveness and sustainable development; sometimes, the concepts are presented as inconsistent, if not opposed. Nor does the department appear to have a consistent view of the connection, whether positive or negative in effect, between stricter environmental standards and industrial competitiveness.

On the other hand, the department has supported commercial opportunities for environmental technologies, for example through its joint support (with ISTC) of the Globe '90 and '92 Trade Show/Conferences for environmental products. The Committee notes that there may be a further opportunity for the regulatory powers of the department to be applied, with some care and foresight, to encourage the development of new industries.

4. Sustainable Development

The department has a large number of environmental programs and policies, a major element of actions in support of sustainable development. This focus is consistent with the Committee's interpretation of sustainable development. In addition, the central focus of the Green Plan is sustainable development. However, the Committee perceived a

heavy emphasis on regulation as a method of achieving objectives, rather than on cooperation or on new technologies and processes.

FISHERIES AND OCEANS CANADA

1. Development of a Knowledge-thirsty Society

The largest proportion of S&T activity of the Department supports its regulatory responsibilities for the fishery; hence S&T activities are considered of interest to a relatively narrow spectrum of Canadians. The overall objective of departmental activities is to ensure that high quality information is available to the government for its use in developing policies and regulations, and available as well to other government departments, private industry and the public. Although new knowledge is created collected, and available it is not, in practice, disseminated widely. Training and licensing programs are supported by the Department; however, the Committee perceives their primary purpose as restriction of the fishery labour force, not the development or transfer of knowledge.

2. Market-driven Technology Development

The Committee believes the government should clarify the objectives, and hence the clientele, of the Department. There could be significant differences in the services required if the objective is perceived as a sustainable industry rather than the previous *de facto* objective of the socio-economic well-being of fishers. With respect to current services, the department avoids duplication with the private sector which develops most of the technologies required by the fishery. The technology development that remains within the department supports its role in the conservation of fish stocks and in the more selective harvesting of the fishery resource. When the Department does develop a process or device of potential use to the fishery, technology transfer is quickly arranged. The greatest proportion of S&T activities within the Department do not concern technology development, however, but the provision of a scientific basis for regulatory activities. New initiatives on consultation should lead to an improvement in relevance of S&T activities to the industry.

3. Competitiveness

Over the last two decades, the Canadian fishery has had a relatively small impact on the balance of payments, although the industry itself has been oriented towards exports.

Activities of the Department have been directed more to maintaining an inherently uneconomic level of employment than to boosting industry productivity. There is recent evidence of change in this area. The Committee notes that aquaculture offers potentially significant opportunities.

4. Sustainable Development

The Committee observes, as have other commentators, that the Department has been encumbered by political and socio-economic objectives, the attainment of which has been inimical to sustainable fisheries operations. In the past, ministerial direction focused the department on the need to maximize jobs and to provide an entry point to the social welfare system, rather than on the need to maintain and develop a sustainable fisheries resource. This has been a great handicap. The Department engages in many S&T activities with the purpose of sustaining the fishery; results are apparent in several sectors of the industry but in others, activities have evidently not resulted in a sustainable resource. The Committee therefore questions the effectiveness of the Department's efforts, but not its commitment.

FORESTRY CANADA

1. Development of a Knowledge-thirsty Society

Technology transfer is among the stated purposes of the department. However, given the lack of take up in the industry, the Committee doubts whether the purpose is being achieved. Forestry Canada publishes material on such subjects as the state of the forest and sustainable forests, but the information appears to have limited impact on the behaviour of industry.

2. Market-driven Technology Development

Weak industry participation in R&D means that a limited amount of technology development is market-driven. Difficulties arise in gaining industry participation even when governments provide the bulk of the financial resources. Weakness in market-driven technology development also results from the peculiar jurisdictional structure of Canadian forestry: companies are harvesters, but not owners of the forests; the provinces are owners and regulators, but not researchers; the federal government is researcher and regulator, but not owner. Further observations on the jurisdictional difficulties appear in the Conclusions section of this Report.

The department's own research program is guided by an external advisory council which could provide the opportunity for the market input into R&D; however, the advisory council is not seen as important by the forest industry. As the department responds formally to the recommendations of its advisory council, the perceived weakness of the council is not caused by any lack of meaningful government participation. The department should seek the advice of industry in building the credibility of the council.

3. Competitiveness

Forest products represent a substantial share of merchandise exports. Declines in industry activity can be attributed to both cyclical and structural factors; however, the perceived weakness in the industry's competitive position may be overstated and is, in any case, reversible. The Committee expressed concern about the impact of its relatively weak R&D performance on the industry's future competitiveness. Members also queried the impact of federal/provincial overlaps in jurisdiction over forestry on spending efficiency.

The departmental S&T budget is focused on the protection and enhancement of the resource base; this is essential to the long-term survival of the industry. Emphasis on the raw resource is partly deliberate strategy but also appears to be the consequence of the delineation of responsibilities between Forestry Canada and ISTC. The Department of Forestry has a relatively small share of the federal S&T budget, given the industry's importance.

4. Sustainable Development

As one of its major missions, Forestry Canada seeks to preserve the raw forest resource. The department's concept of sustainable development has become more sophisticated in recent years; programs such as the creation of model forests emphasize interdependence of ecological systems while permitting harvest for human use. There is also considerable focus on external factors affecting the resource, such as climate change.

HEALTH AND WELFARE CANADA

1. Development of a Knowledge-thirsty Society

Health and Welfare Canada communicates health information through a number of publications. However, the Committee could find no compelling evidence that the department is aware of the principle, let alone supports it.

The Committee believes that the department can do more to communicate information on disease prevention. In addition, as argued below, the Committee sees an opportunity for the department to participate in the dissemination of information on commercial opportunities in the health care and medical devices industries.

2. Market-driven Technology Development

The Committee understands and supports the Department's commitment to affordable, sustainable, quality health care. However, the department appears to have no interest in the opportunities for growth of firms in the Canadian health care industry. Indeed, new medical technologies are perceived as a burden on the cost structure of the health care system. While new technologies can add costs, they can also lead to reductions. The Department's perception seems not to be responsive to the cost reduction opportunities that can result from technological developments.

Officials identify clients of the department as Canadians. This leaves little scope for appreciating industry as a client, whether in the area of regulation or technology development. The Committee suggests the department develop greater awareness of the opportunities for Canadian industry in health care. Industry should be recognized as a client of the department. Health care technologies studied by the department could create significant commercial opportunities.

3. Competitiveness

A healthy population is a necessary part of the infrastructure for a competitive economy. The health care system is directly linked to our standard of living; its cost is an element affecting the efficiency of our economy. The activities of the department in maintaining food and drug safety are an important contributor to our standard of living.

The Committee did not find a strong awareness within the department of the connections between national health and competitiveness at a general level. More specifically, the Committee found little evidence that the department is directly concerned with the costs of maintaining the health care system.

4. Sustainable Development

The Committee noted one program was concerned with the maintenance of environmental quality and the avoidance of hazards. Work on epidemiology could also be considered supportive.

INDUSTRY, SCIENCE AND TECHNOLOGY CANADA

1. Development of a Knowledge-thirsty Society

In both mission and action, the department is fully aware of the importance of knowledge to future prosperity. ISTC leads or supports a number of programs to build public awareness about S&T. The department funds a scholarships program to provide incentives for students to undertake post-secondary studies in science, technology and engineering. A number of programs and specific initiatives support the diffusion of knowledge and technology to the private sector. Policy initiatives in such areas as intellectual property also support the diffusion of knowledge.

2. Market-driven Technology Development

The greatest proportion of ISTC grants and contributions is in response to requests from firms; in that sense, the S&T funding responds to the market. However, a disproportionate share is allocated to a relatively narrow spectrum of the industry sectors served by the department. The department receives advice from a number of external boards (some supported by ISTC) and responds to that advice. Indeed, a significant proportion of departmental activity is dedicated to industry consultation and consequential support.

3. Competitiveness

Competitiveness is the core of ISTC's mandate. S&T is recognized to have a pre-eminent role in achieving this objective, a role reflected in budgetary allocations. The industry sectors served by the department form the largest portion of our merchandise trade exports. The Committee notes that ISTC gives particular emphasis to such sectors as aerospace (especially in terms of direct financial support), but relatively less to other major contributors to our trade position. International trading rules limit the direct assistance the department can provide directly to non-defence-related industries but there are many other forms of allowable support, in such areas as pre-competitive research and the development of industry's knowledge infrastructure.

4. Sustainable Development

Some relatively small programs exist to develop environmental technologies. ISTC has an Environmental Affairs Branch.

INTERNATIONAL DEVELOPMENT RESEARCH CENTRE

1. Development of a Knowledge-thirsty Society

IDRC considers its key role to be a knowledge-broker. “Empowerment through knowledge” is a central theme for IDRC and the creation and use of relevant knowledge is a clear objective in all the Centre’s programming. From the perspective of IDRC managers, one measure of the Centre’s effectiveness is the degree to which programming adds to the indigenous research capacity in the developing country or area. In other words, success in developing a knowledge-thirsty society is a key criterion for the evaluation of programming. In addition, through its use and development of networks, its library and database services, IDRC is at the forefront of the development of new techniques for the dissemination of knowledge. The Centre uses a number of techniques to build Canadian awareness of its activities and of the needs of developing countries: these include conventional and electronic publications, education and cost-shared research. The Committee believes that IDRC could do more to develop the knowledge flow from South to North.

2. Market-driven Technology Development

Developing countries are the primary clients for IDRC programming. IDRC maintains excellent contact with its clientele, through Board representation, regular consultations and special conferences and fora. Of particular note is the presence of client representatives on the Board of Directors of the Centre; this practice is also applied by commercial enterprises with highly developed quality management programs. IDRC also works to develop the sophistication and discrimination of its clients, by supporting the development of networks through which countries can learn from each other and cooperate on issues of common concern. The Committee concludes that very little of the Centre’s activities is driven by factors other than clear client needs.

3. Competitiveness

IDRC tries to develop the competitiveness of its clientele, the developing world, “by intensifying the process of generating, disseminating and applying relevant scientific and other knowledge”. The Committee is convinced that such a strategy is as appropriate for developing countries as it is for Canada.

4. Sustainable Development

The Centre has a specific mandate for sustainable development, given by the Prime Minister. A number of specific R&D programs are supportive of sustainable development objectives. Most importantly, however, sustainable development forms the framework within which all programming is assessed.

MEDICAL RESEARCH COUNCIL

1. Development of a Knowledge-thirsty Society

MRC has a specific mandate to create new knowledge, and the largest portion of its budget is directed to that end. The Council also directs resources to the development of highly qualified personnel. Within those general priorities, the Committee could not find evidence of an overall strategy for the allocation of resources among various types of grant support or among the various disciplines of health research. The Council has, however, taken some initiatives to develop new perspectives on medical research, such as the new focus on health systems research. The Committee believes that MRC could promote its considerable accomplishments more effectively. Increased dissemination and popularization of research results are called for in the Council's Communications Strategy.

2. Market-driven Technology Development

The primary clientele of MRC has been the academic medical research community, and the organization has been responsive to client needs. The Council has also supported the development of collaborative ventures and partnerships with private research organizations and private enterprise. MRC has been responding to its market. In fact the Council is placing less emphasis on its role as the contributor of funds and more on its capacity to act as a catalyst and the provider of core services. This represents a quantifiable demonstration that the market is driving technological development. One research project (the Breast Cancer Initiative) responded to a request from a Parliamentary Committee; this was appropriate direction, both because the Council reports to Parliament and, more importantly, because the Parliamentary Committee was expressing the concerns of the potential direct beneficiaries of medical research. Recently, the MRC Council has begun to redefine its clientele as those engaged in the provision of health services rather than those solely in the development of medical knowledge. This is a bold initiative. The MRC Strategic Plan proposes that the redefined clientele guide future MRC programming.

3. Competitiveness

MRC is well aware of the many linkages between population health and competitiveness. The Council monitors health care costs as a proportion of national output, but argues (with evidence in support) that medical research can lead to reductions in the cost of the health care system. The new focus on health systems research supports the linkage.

4. Sustainable Development

Some research programs concern environmental impacts. MRC has no specific research programs related to the objectives of sustainable development.

NATIONAL DEFENCE

1. Development of a Knowledge-thirsty Society

With the exception of some support for civilian research in military or strategic studies, the department has a limited role in development of a knowledge-thirsty society. DND has recently increased its efforts in technology transfer.

In the Committee's view, there is an opportunity for the department to make an important contribution to the development of a knowledge-thirsty society, even within the constraints of national security. A significant proportion of military technologies are dual purpose (i.e., have a conceivable civilian use). Both with respect to its own research programs and the very considerable amount of research and technology prospecting done by the department, there is an opportunity to make this knowledge available to the industrial and educational sectors.

2. Market-driven Technology Development

The R&D function of the department (Chief, Research and Development: CRAD) considers the following groups as its clients: the three Forces, Canadian industry, allied Ministries of Defence, the Canadian S&T community and the Canadian public. The sheer diversity of the client base raises questions about the capacity of the department to be sensitive and responsive to its needs. However, even when the client base is limited to the Canadian Forces, there appears to be an uncertain relationship with clients. For example, only the Navy seeks research on domestically-designed weapons platforms.

Procurement attitudes within the department do not appear to support Canadian development or design.

3. Competitiveness

The department's S&T programming, usually in support of government procurement, has contributed to the competitiveness of certain specific companies. However, such is usually a fortuitous result rather than an intended goal. The Committee found that operational requirements are not defined with any relationship to Canadian competitiveness.

4. Sustainable Development

The department has no formal role or mandate in this area. However, the department supports the development of waste treatment activities and has taken a more active role in environmental assessment and clean up of its activities. DND has appointed a Director General responsible for environmental activities.

NATIONAL RESEARCH COUNCIL

1. Development of a Knowledge-thirsty Society

All programming within NRC supports the creation and dissemination of new knowledge. The Committee found the organization particularly strong in the number and use of its linkages between research laboratories and the private sector or other research organizations. The services of the Industrial Research Assistance Program and the Canada Institute for Scientific and Technical Information also make a major contribution to the dissemination of knowledge. The organization's programs with students are extensive and represent an important contribution to national development of human resources. NRC has re-made itself over the last decade; the changes, though extremely disruptive at the time, have resulted in an organization that is very focused on the 'knowledge-thirsty' principle.

2. Market-driven Technology Development

The Committee found NRC to be a very client-oriented organization; indeed, there appears to be relatively little activity that is not guided by external client needs. The organization is challenging itself to become even more client-oriented by establishing a

target of doubling, by the year 2000, the total financial investment in R&D that NRC stimulates and jointly sponsors with others. For the Committee, client contributions are an important gauge of the commitment of a client or research partner. The Committee also observed that advisory boards and consultative mechanisms are active and effective.

3. Competitiveness

Industrial competitiveness is a major objective for NRC. indeed, the overall direction of NRC is guided by its third long-range plan called *The Competitive Edge*. The objective was developed through consultations with other national science agencies and federal departments. The work of the NRC Research Institutes is focused on pre-competitive research, but it is clear that industry partners have a competitive purpose in mind. IRAP strongly supports the competitiveness of its clients.

4. Sustainable Development

NRC has established two Institutes which focus on issues related to the environment: one concerns environmental chemistry, the other engineering in the Canadian environment. Other environmental research work takes place in biotechnology, biosciences and marine dynamics. Sustainable development is not an organizing principle for general Council programming.

NATURAL SCIENCES AND ENGINEERING RESEARCH COUNCIL

1. Development of a Knowledge-thirsty Society

The business of NSERC is support for the creation and dissemination of knowledge. The Committee was favourably impressed by NSERC's efforts to encourage collaborative and strategic research. The Council makes periodic efforts to reallocate research funds to areas where the need for research is perceived to be the greatest; i.e., it prioritizes. In making an assessment of relative need, NSERC officials meet with business development officers in universities and work with officials of SSHRC. In addition, the peer review system is being used to evaluate not only the scientific value of research but also the value of the research to society. However, the Council would oppose any attempt to impose a relevance-based allocation among research fields. The Committee also endorses NSERC's considerable efforts to support the development of the highly qualified personnel on which the creation of new knowledge depends.

2. Market-driven Technology Development

NSERC is responsive to the needs of the university research community. The Council also consults with industry in determining strategies, and funds programs to build linkages between industry and universities. The Committee had some concerns about the Council's capacity to act independently of historical precedent in the allocation of grants; i.e., its flexibility in responding to changed circumstances. This concern is shared by the Council, as a new allocations system is under development. The Committee would also like to see a more precise definition of NSERC clients. The people of Canada are not the clients for NSERC research even though they benefit from it; clients have a direct role in determining the nature of the product.

3. Competitiveness

Technological development, and hence competitiveness, within Canadian industry depends primarily on research achievements in the natural and social sciences, whether in Canada or abroad. NSERC is a key player in the funding of R&D, in the training of highly qualified personnel and in the diffusion of knowledge and technology; all of these are necessary for industrial growth and renewal. The Committee observes, however, that industrial competitiveness is often a fortuitous benefit of NSERC-supported research, rather than the output of a deliberate strategy. It is fully appropriate for a University Granting Council to adopt such an approach, but it naturally limits its responsiveness to this criterion.

4. Sustainable Development

NSERC provides many research grants in support of the scientific foundation for progress in sustainable development. In addition, the Council participates in shared programs on Eco-Research and Global Change. However, sustainable development has not yet acquired disciplinary status within the Council, nor is it an element by which the Council allocates funds for research programs.

SOCIAL SCIENCES AND HUMANITIES RESEARCH COUNCIL

1. Development of a Knowledge-thirsty Society

The creation and dissemination of knowledge are at the core of SSHRC objectives and operations. The Council is a leader in setting performance benchmarks for the wide

dissemination of knowledge. The Committee believes that the knowledge available from SSHRC-sponsored research can be of considerable use in addressing current societal issues or aspirations. The Council is beginning to support more directly the development of a science culture, working in collaboration with the private sector. Although SSHRC requires researchers to consider the potential uses of their research, the Committee would have liked to see more evidence of the impact of SSHRC research on decision-making in the public and private sectors.

2. Market-driven Technology Development

The primary clientele of SSHRC is the university community. The Council maintains strong and sophisticated linkages with this clientele, to the extent of 'auditing' its grant selection process to ensure fairness. Other clients are those public and private sector organizations or groups with which SSHRC collaborates. Although there is some emphasis on consultation and collaboration with public and private sectors to reinforce linkages between the university community and research users, the Committee sees further opportunities, as does SSHRC itself, to develop those linkages and broaden its client base.

3. Competitiveness

The concept of 'competitiveness' as a policy objective has its source in the social sciences. Research sponsored by SSHRC can have a large impact on the ability of the Canadian economy to be competitive and to adjust to technological, market and societal changes. As examples, the Council supports work on economic policy, on labour-management relations, and on the understanding of the cultures and markets of our international competitors. SSHRC also intends to review the role and relevance of graduates in the social sciences and humanities in a changing socio-economic environment. In the view of the Committee, SSHRC could do more to ensure that research results are available to firms and to persuade Canadian business of the necessity of adaptation to the changes in world trade.

4. Sustainable Development

SSHRC participates in cooperative research programs on eco-research. The Committee notes, however, that sustainable development is but one issue among many of concern to SSHRC.

STATISTICS CANADA

1. Development of a Knowledge-thirsty Society

The purpose of the organization is to collect and disseminate information. The Committee found that the Agency communicates effectively and develops interest in statistical measurement of a wide variety of economic and social phenomena.

2. Market-driven Technology Development

The Agency is advised by an External Council, which appears to have an impact on programming. Significant internal resource allocations are made in response to changed priorities. The organization appears to respond to market signals in the pricing of services.

3. Competitiveness

A good statistical system forms a vital part of the data infrastructure of a knowledge-intensive economy. Statistics on industry performance, trade and competitiveness allow identification of areas of strength and weakness; they also permit individual firms or sectors or other categories to benchmark themselves. The Committee views the RSA activities of Statistics Canada as very important to maintaining and improving our competitive position.

The Committee notes that the provision of timely, regular and accurate statistics on federal S&T spending is an important base for management of that spending. Reductions in the frequency or depth of data collection run contrary to the governments efforts to manage S&T as a priority.

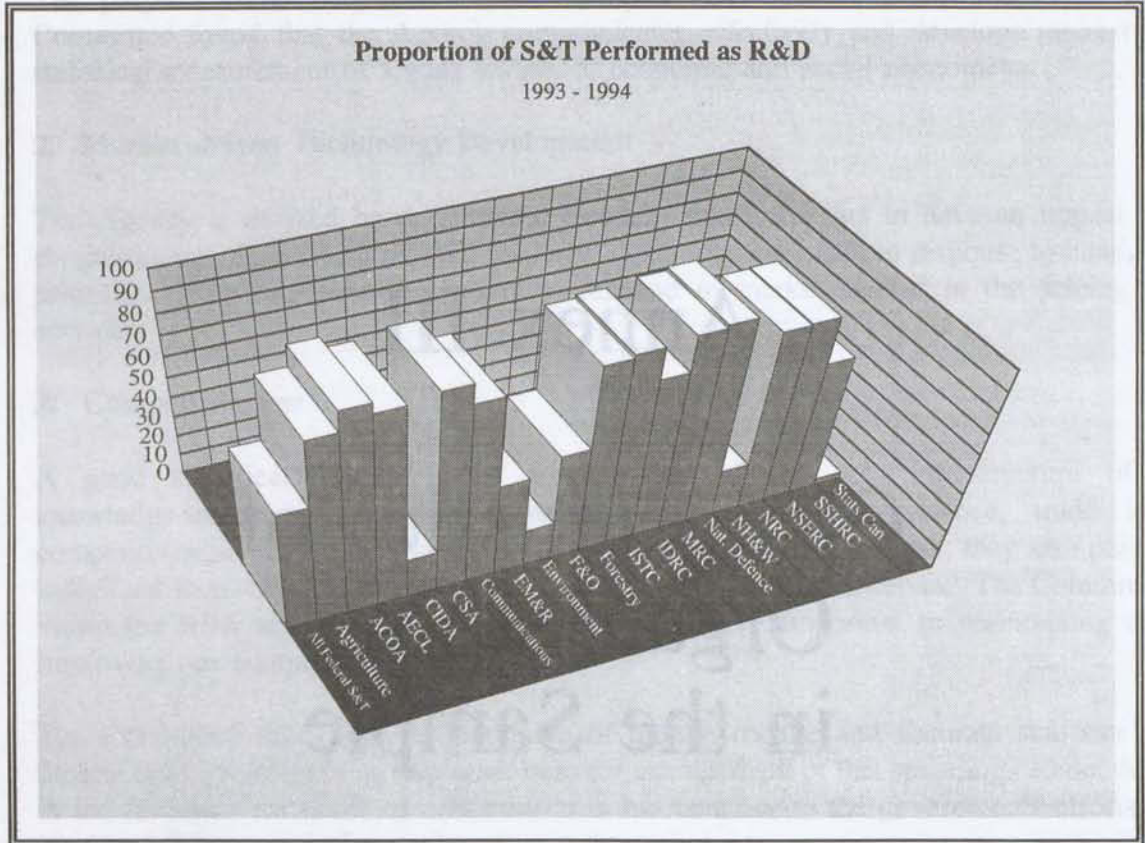
4. Sustainable Development

The Agency is studying the integration of environmental accounting into the National Accounts; such would permit a greater statistical understanding of the national impact of the environment. Collection of health statistics also permits more precise identification of environmental threats. The Committee observed that it would be difficult for a national statistical agency to have any pronounced impact on sustainable development.

Annex III

Characteristics of Organizations in the Sample

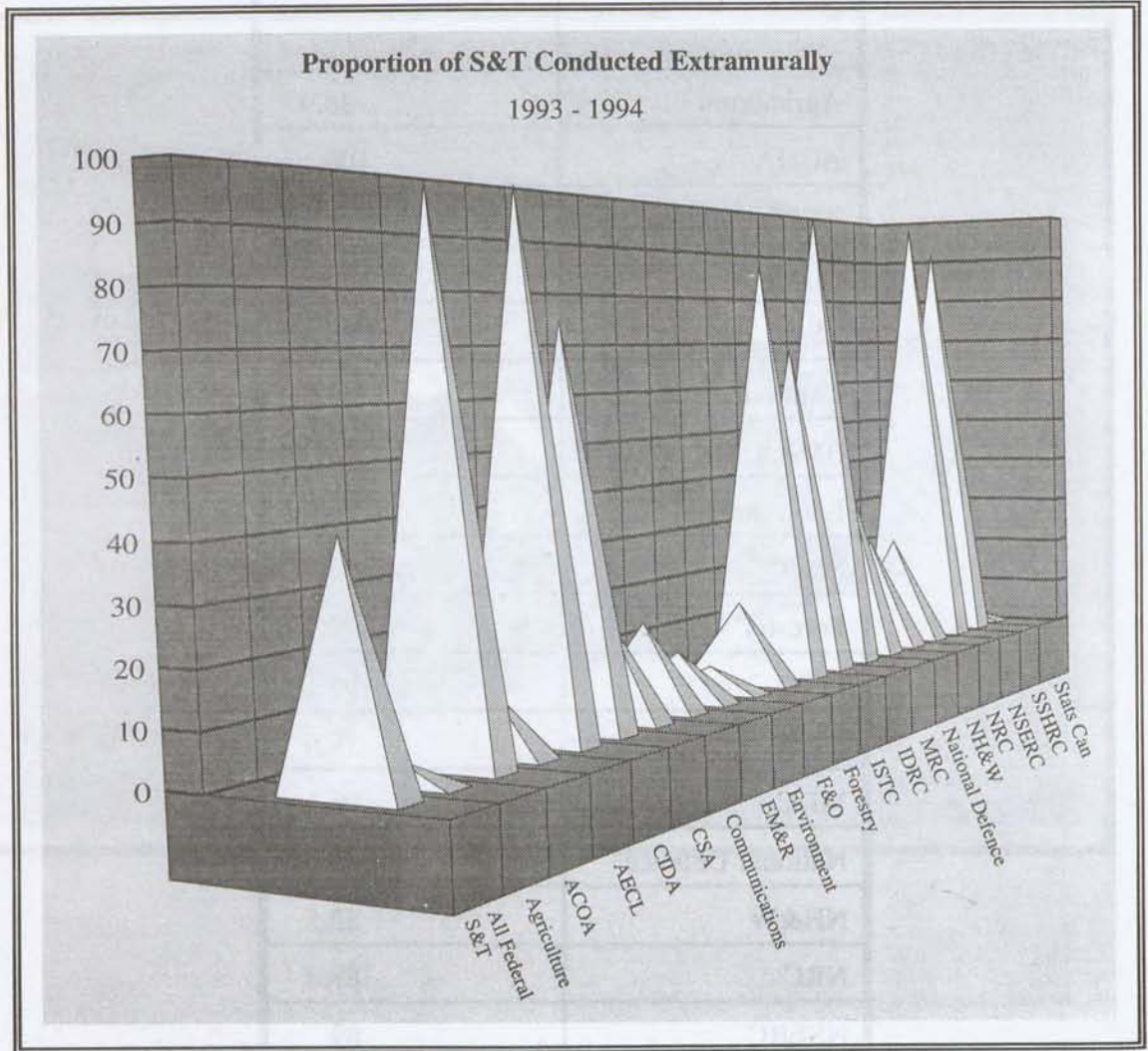
Characteristics of the 19 Organizations (I)



**Proportion of S&T Performed as R&D
Chart Data as Table**

Org.	Prop. R&D
Agriculture	88.9
ACOA	100
AECL	95.3
CIDA	20
CSA	98
Communications	88.8
EM&R	45.5
Environment	18.8
F&O	53.1
Forestry	92.4
ISTC	94.1
IDRC	79.6
MRC	96.1
National Defence	97.6
NH&W	22.5
NRC	88.4
NSERC	89
SSHRC	67.2
StatsCan	3.4
Total S&T	59.7

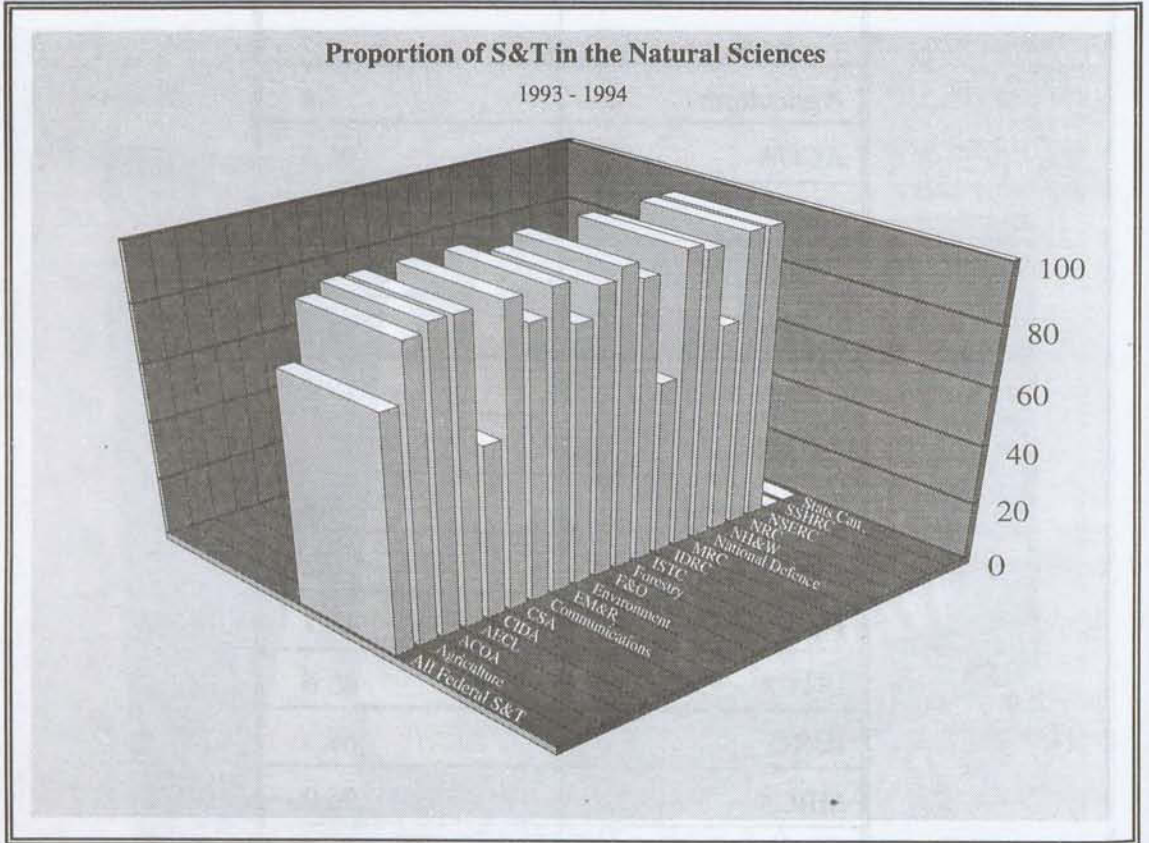
Characteristics of the 19 Organizations (II)



**Proportion of S&T Conducted Extramurally
Chart Data as Table**

Org.	Prop. Extramural
Agriculture	3.4
ACOA	96.4
AECL	12
CIDA	97.2
CSA	74.1
Communications	19.6
EM&R	17
Environment	9.8
F&O	5.2
Forestry	16.7
ISTC	85.6
IDRC	68.3
MRC	96.9
National Defence	41.8
NH&W	23.8
NRC	23
NSERC	96
SSHRC	90.7
StatsCan	0
Total S&T	41.2

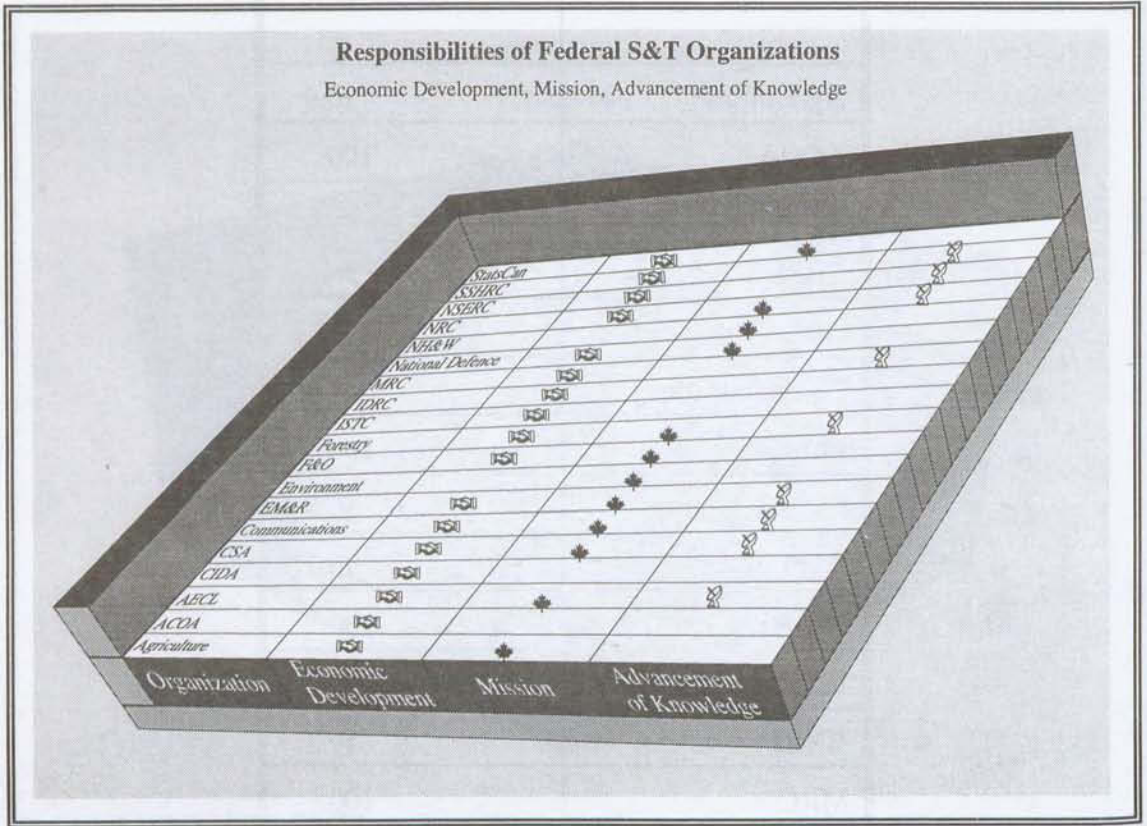
Characteristics of the 19 Organizations (III)



**Proportion of S&T in the Natural Sciences
Chart Data as Table**

Org.	Prop. Natural Sci.
Agriculture	96.9
ACOA	100
AECL	100
CIDA	58.2
CSA	100
Communications	91.3
EM&R	100
Environment	86.8
F&O	96.2
Forestry	100
ISTC	94.5
IDRC	59
MRC	100
National Defence	97.7
NH&W	71.8
NRC	100
NSERC	100
SSHRC	0
StatsCan	0
Total S&T	78.3

Characteristics of the 19 Organizations (IV)



Annex IV

Official Names, Alternate Names, Abbreviations and Acronyms

The 19 Selected Organizations

Official Name	Alternate Name	Short Form, Abbreviation or Acronym	Status after Reorganization of Government
Agriculture Canada	Department of Agriculture	Agriculture, Agr. AgCan	now Agriculture and Agri-Food
Atlantic Canada Opportunities Agency		ACOA	Same
Atomic Energy of Canada Limited		AECL	Same
Canadian International Development Agency		CIDA	Same
Canadian Space Agency		CSA	Same
Communications Canada	Department of Communications	DoC, Communications	Non-culture parts of portfolio merged with Industry Canada
Energy, Mines and Resources Canada	Department of Energy, Mines and Resources	EMR, EM&R	merged with Forestry to become Natural Resources Canada
Environment Canada	Department of the Environment	DoE, Env., Environment	Same
Fisheries and Oceans Canada	Department of Fisheries	DFO, FOC, Fisheries	Same
Forestry Canada	Department of Forestry	Forestry	merged with EM&R to become Natural Resources Canada
Health and Welfare Canada	Department of National Health and Welfare	NHW, H&WC	now Health Canada ; social welfare programs transferred to Human Resources Development
Industry, Science and Technology Canada	Department of Industry, Science and Technology	ISTC	now Industry Canada ; was Industry and Science Canada for four months.
International Development Research Centre		IDRC	Same
Medical Research Council		MRC	Same

Official Name	Alternate Name	Short Form, Abbreviation or Acronym	Status after Reorganization of Government
National Defence	Department of National Defence	DND, Defence	Same
National Research Council		NRC	Same
Natural Sciences and Engineering Research Council		NSERC	Same
Social Sciences and Humanities Research Council		SSHRC	Same; (merger with Canada Council not approved by Parliament)
Statistics Canada		Stats, StatsCan, DBS	Same

