CANADA

Report of the
National Advisory Board
on Science and Technology

BIG SCIENCE COMMITTEE

Presented to the
Prime Minister of Canada

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May 15, 1989

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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BIG SCIENCE COMMITTEE

Terms of Reference

The mandate of the committee was to:

> recommend to the Prime Minister a policy framework, a set of guidelines, and a management process for deciding which "Big Science" projects to support, taking into account the five strategic objectives of the government's science and technology strategy, InnovAction, and the principles underlying the Decision Framework, with particular attention to:

a) scientific needs;

b) impacts on the overall S&T and federal budgets;

c) industrial and technological opportunities;

d) federal-provincial considerations;

e) international considerations.

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BIG SCIENCE COMMITTEE REPORT

1.0 INTRODUCTION

Big Science is not a new issue. Twenty years ago Harvey Brooks wrote: "The past 15 years have seen even pure science carried out on an entirely new scale. We have the new phenomenon loosely known as 'Big Science'. That is pure science, carried on with complex and expensive equipment and with a large supporting technological effort. Ranked in order of costs, the most important examples of such Big Science are space sciences, high energy physics, oceanography, radio astronomy and optical astronomy."

That was 20 years ago. Since then the rapid pace of scientific knowledge has lengthened the list to include nuclear physics, fusion, materials science and superconductors. In the future, we can expect to see new additions in such areas as biotechnology and atmospheric research.

The message is that Big Science is not a transitory phase, it is an issue that is now at least 35 years old. If Canada is to continue its technological development among the industrialized nations, we must invest in Big Science projects. The question is not whether or not, but rather, taking into account our resources to support science, it is how much and in what areas?

In its brief survey of Big Science in Canada, the Committee found that Canada has been quite active in such areas as space, particle physics, astronomy and fusion, but that in general, our total rate of investment in Big Science relative to other G7 nations is modest. Perhaps, just because of the modest budgets, we found that many of our Canadian scientists heavily network into world facilities, and that there are many innovative examples of cost-effective Canadian facilities.

Ultimately the ability of Canadian scientists to gain access to and make effective use of the world's best facilities will be dependent upon the skills and knowledge they are able to develop in Canadian facilities. These will be expensive and we must, therefore, choose carefully since Canada will not be able to afford many. The Committee is concerned as to whether we are making the appropriate investments in Big Science, given the ad hoc nature of the current decision-making process.

A common characteristic of Big Science projects is that they are too large to be handled within the budgets of our established scientific funding agencies, i.e., federal departments, institutes and granting councils. Thus, these bodies cannot approve the programs and this has led to the situation where Big Science projects do not have a forum to arbitrate priorities and make the decision on whether or not they will go ahead. Consequently, many such projects have been elevated to the lobbying and political decision-making machinery of Canada, with the result that rational decisions are not always possible.

For the purpose of this report, we have, therefore, defined Big Science as those projects and programs which are too large to be handled within the budgets of our established granting agencies. One cannot draw a hard and fast line, but projects exceeding $25 million over a period of five years or less currently strain the capacity of our existing processes and, therefore, qualify as Big Science.

It is the financial strain on our existing processes, created by Big Science projects and their follow-on funding commitments for maintenance of the facility, that make this an urgent issue. The basis of Canada's current scientific strength is the effectiveness of our "little science" program. We must not enter new Big Science projects at the expense of cutting, or otherwise handicapping our "little science" efforts. The Committee sees this as a basic ground rule in our approach to funding Big Science projects.

The Committee has focused on developing a set of recommendations which can be grouped into two areas: Objectives and Criteria, and Decision Mechanism.

2.0 RECOMMENDATIONS

2.1 Objectives and Criteria

2.1.1 Scientific Excellence and Value

a) The first and necessary criterion for a "Big Science" project should be scientific excellence as confirmed by international peer review. This is particularly true of pure science projects where the objective of the facility is for Canada to play its role in advancing the world's scientific knowledge.

b) We need high-calibre proposals that will attract the best minds in the field to use the new facility. The project should bring a unique and significant contribution to the international network of other such efforts. Its quality, uniqueness and significance should normally be sufficient to lever international financial support of at least 25 percent of the project cost.

c) We must also attempt to predict the scientific value of the new facility or project. Will it allow scientific knowledge to move to new levels or will it only be incremental in character? Given the magnitude of the Big Science expenditures, it is important that we use these projects to drive technology to raise our knowledge to new levels. Big Science projects must truly be in support of "big" ideas.

2.1.2 Social and Economic Benefits

a) Training of Engineers and Scientists — Another primary objective of Big Science facilities and projects is to maintain a supply of first-class scientists and engineers. These investments will allow Canada to attract and retain first-class professors who will maintain their knowledge through leading edge research at these facilities. Clearly then, facilities should be selected that will provide the types of talent Canada will require over the long term. We need to ensure that Canada can productively use the resources trained at the facility.

b) Technological Benefits — Big Science facilities can drive technology to deliver new capabilities. Precision instrumentation, high-stress materials, and control systems are only a few examples of areas that can be advanced by these scientific investments. There is a need to assess the value to Canadian industry of the technologies that will evolve as we create, maintain and develop the facility. Such projects can increase technological skills and, maybe, allow Canadian industry to enter new markets.

c) Focus for Regional Development — It is reasonable to expect that these domestic facilities will become regional centres for the development of knowledge, as well as for secondary scientific and industrial spin-offs. This will be a factor in deciding upon the location of the investments.

d) Public Awareness of Science and Technology — These types of projects should be sources of pride in our scientific and technical accomplishments. This will have an impact on selection criteria, as it is important that Canadians be able to appreciate the significance of the initiative and thus support the objectives of the project. The successes of Canadians in domestic and international facilities should be widely publicized as part of a more general effort to raise the level of science and technology awareness in Canada.

2.1.3 Cost Effectiveness

The significance of the expected advance should be commensurate with the size of the investment contemplated. Large investments should attempt to raise scientific knowledge to new levels. In addition, proposals need to be examined to see how much of the expenditure is used to drive and foster new technology and capabilities, rather than mere investment in "bricks and mortar" or other routine tasks.

2.1.4 Management Capabilities

The levels of commitment should be high and the proponents should provide evidence of an appropriate administrative structure, together with a demonstrated competence to manage such a project.

2.1.5 Priority Setting

In the absence of a formal budget for Big Science projects, each candidate project must be reviewed against the merits of other opportunities. The selection must be made on the basis of Canada's overall best future interests. Ad hoc program approval could easily pre-empt our ability to resource other projects that would, perhaps, be more strategic to Canada's long term interest. This consideration brings us to the "Decision Mechanism".

2.2 Decision Mechanism

Canada, like many other nations, has not put in place mechanisms for dealing with the continuous flow of ad hoc Big Science proposals. Furthermore, the problem is not just a matter of selecting between proposals, it is an issue of providing leadership — leadership to stimulate and shape proposals that, when implemented, will be key steps towards realizing our vision of Canada. Leadership, hence, requires being proactive, not reactive.

a) It is the view of the Committee that an organization must be charged with the task of formulating Canada's scientific priorities and providing the leadership by setting the framework for the selection of all major federally funded science and technology initiatives. The mandate of this body must include the major scientific facility investments of all departments to ensure that our future needs are given appropriate support in the areas of fusion, the oceans, the environment, space, communications, and health as well as the needs of the pure science. It is essential that we establish a process that will allow for the comparison of the merits of the individual candidate projects with those of other major projects that will come forward during the major expenditure years of the proposal under consideration.

b) Such a comparison is not currently possible since the various line departments can commit expenditures to major projects that, while individually deserving, may be of lower priority than the needs of Canada in other areas. These decisions must be made in the context of Canada's total needs and opportunities.

c) Within Government, the appropriate department to house this body is ISTC. However, it would require the authority to set science and technology priorities across all departments with significant science and technology programs. We view this as a continuation and formalization of the successful approach initiated by MOSST and NABST last year.

d) We feel that NABST, which represents the collective judgement of industry, academia and labour organizations, could provide extremely valuable input that would assist ISTC in the formulation of these priorities.

e) Within the framework of priorities determined by the organization, we believe that the various granting councils, together with NRC, already have extensive and well-respected mechanisms for the evaluation and tracking of scientific projects. However, It is recommended that, for the Big Science projects, the councils augment their review with an international peer review of the scientific quality, uniqueness and significance of the proposal in an international context. The mandate of these councils would be to judge the scientific merits of new Big Science proposals. The actual decisions on which projects best fit Canada's long-term strategic interest would be made by ISTC, with the support and advice of NABST.

f) It is recommended that ISTC, together with NABST, annually review the existing and upcoming Big Science proposals to track their progress, adjust priorities to identify those areas where reductions are appropriate, and identify strategic areas where proposals need to be initiated or approved to meet Canada's long-term objectives.