ISSUES RELATED TO EVALUATION AND IMPACT ASSESSMENT OF RESEARCH AND DEVELOPMENT PROGRAMS AND THEIR RELEVANCE TO "SERC IN INDIA"

By

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Issues related to Evaluation and Impact Assessment of Research and Development Programs and their relevance

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Executive Summary

This report is prepared as part of the Pearson Fellowship Program of International Development Research Centre.A key element of the program,the aspect that will focus the Canadian experience and make it relevant,is the called Research Management Project.The project should focus on a real challenge in science policy or research management.Looking to the financial constrains in the developing countries, the evaluation of Research and Development program is the real challenge. Efforts are being made to evolve better methodologies to assess the impact of the science and engineering on the society.

This report attempts to focus some of these issues related to the evaluation of R&D programs in the Canadian context particularly for basic research and its relevance to Science and Engineering Research Council (SERC) in Indian context.

Objectives of the Project

1. To study the Canadian experience in evaluation and impact assessment of R&D programs and extract those elements relevant to the Indian context.

2. To look at the methods of obtaining feedback from output of research projects in order to modify the existing policies of funding.

3. To recommend a model approach for SERC in the Indian context.

The report is based on interviews and evaluation reports of the operating grants and strategic grants programs of Natural Science and Engineering Research Council of Canada. While interviewing NSERC officials and going through the evaluation reports, it was clear that some of the issues are common to both countries. However there is a substantial difference in the investment in R&D programs.

In evaluating basic research one, can focus on the following three issues:

1. Rationale of the program
2. Objectives of the program
3. Impact of the program
4. Program delivery process

An attempt has also been made to propose a plan for an evaluation function within the Science and Engineering Research Council(SERC) program in the Indian context based on the Canadian experience.

1.0 Introduction

In its essence, research in Natural Sciences and Engineering is the pursuit and production of knowledge. To measure the impact of this production process requires the measurement of knowledge. However knowledge cannot be measured directly. What can be observed and measured are the expressions of knowledge, such as papers, patents, and students educated. Because of multi-dimensional and multi-faceted nature of knowledge, its expressions represent only components and lower-dimensional projections of the full scope of the knowledge gained from research. Therefore, measures of the expressions of knowledge resulting from research must of necessity provide an incomplete picture of the research product.

Impact of a research program is a complex concept,since it involves identifying the variety of expressions of knowledge produced,as well as the changes which these expressions effect on a multitude of different areas (other research areas, technology, organizational missions, education, social structure etc.). While some impacts may be tangible (new instrument developed, new research fields stimulated, students trained in new disciplines), many may be intangible (e.g. a designer of equipment may receive new insights from having attended a research seminar), and difficult to identify, much less quantify. Therefore, measures of the impact of research are by nature incomplete and in some cases provide a false picture of a research program.

In addition, for many research sponsors, generic impact alone is insufficient. The research impact desired is where the production of knowledge is aligned in the direction of organizational targets, and the research product will help in the attainment of organisational goals. Thus, the impact of a given research program with given targets might have far different meaning depending on whether it was performed for the Department of Energy or Department of Environment. One would also expects that understanding and measuring the impact of research are desired by research sponsor organisations at every stage of research cycle, including research topic identification, research selection, research management and evaluation, research termination. Research impact evaluations are of potential use to sponsors in:

> **Deciding whether to continue or end the program or to increase or decrease its budget; changing the program, or its management, to improve the probability of success, altering policies regarding the procurement, conduct, or management of research, and or building support with policy makers and other constituencies of the program.** (Salasin,1980)

In the research identification and selection phases, before the research is under way, nearly all sponsors desire projections of the potential impact of research to be funded. For very fundamental research, these projections tend to focus on gaining a greater understanding of basic mechanism, and perhaps on the stimulation of new research fields. As the research becomes more applied, then potential impacts on technology and organisational missions may be estimated.

1.1 Why Evaluate Research Now?

The best answer to this important question is that the Policy-Makers in S&T organizations, R&D managers and politicians want to know what the scientific research community is doing and how well it is doing. More than ever before, national well-being is dependent on national research capability. Success in the competitive, problematic world of the nineties and the twenty first century will depend on having in place the qualified people who alone can create and provide awareness of new knowledge wherever it has been generated and the capability for selecting, adopting, adapting and exploiting that knowledge for the benefit of the citizen of the nations.

1.2 Structure of the Project report

The report has been divided into seven chapters. In the following chapters, the objectives of the project, type of R&D programs and issues related to evaluation and impact assessment of research in Canadian context are discussed. In order to understand the criteria and methodologies involved in evaluation process, two case studies of "Operating Research Grants" and "Strategic Grants programs" of Natural Science and Engineering Research Council of Canada (NSERC) are included. These two programs have similar objectives as Science and Engineering Research Council in India (SERC) has. From these studies an attempt has also been made to suggest model approach for the evaluation of SERC program in Indian context.

2.0 Background and objectives of the Research Management Project (RMP)

2.1 Background of the project (Indian context, need, overview)

During the last decade or so, several government agencies in India have taken up R&D programs and schemes in accordance with the aims of the Scientific Policy Resolution (4th of March 1958) of the Government of India (Annexure I). In order to pursue these aims, the Government of India is allocating approximately 1.1% of the GNP (1989-90) to related S&T activities in the country. The resources for carrying out R&D activities in the country are mainly assigned to the scientific departments/agencies (DST, DSIR, CSIR, DBT, DOD, DAE, DRDO, DOS etc.) as well as to more than 30 socio-economic ministries/departments for their S&T component (including ICAR, ICMR, DOEn, DNES, Coal, Chemicals, Mines etc.). A small fraction of the total resources are also allocated for S&T activities in the states in their respective plans. During the 7th Five Plan (1985-90), the allocation for these three resources of S&T activities in the country were as follows:

Annexure I

SCIENTIFIC POLICY RESOLUTION (1958)

- To foster, promote and sustain by all appropriate means the cultivation of science and scientific research in all its aspects - pure, applied and educational

- To ensure an adequate supply of research scientists of the highest quality within the country

- To encourage and initiate with all possible speed programs for the training of S&T personnel

  ....etc

- In general to secure for the people of the country all the benefits that can accrue from the acquisition and application of scientific knowledge
  - 14 S&T agencies
  - 30 socio-economic ministries
  - 150 universities

(a)	Outlay for central S&T agencies as a percentage of the total public sector outlay	1.09%
(b)	Outlay for S&T in socio-economic sectors as a percentage of total public outlay	1.09%
(c)	Outlay for S&T in states as a percentage of total public sector outlay	0.05%

The scientific agencies and the socio-economic ministries have utilised the allocated S&T resources mainly for the activities performed in their own institutions, organisations and laboratories which cater to the needs of the requirements of the Departments/Ministries. Over the years, with the growth of the scientific activities and their increasing interdisciplinary nature of as well as greater awareness for research in educational institutions and industry, it has become necessary for S&T Departments/Ministries to reach out and specifically commission R&D activities outside their own institutions.

Recognising this fact, the Department of Science and Technology (DST) has instituted a special mechanism "Science and Engineering Research Council (SERC mechanism) to fund research outside their own institutions, e.g. universities, IIT, national laboratories, school of excellences, private sectors etc. Such a mode of supporting R&D activities is termed as "Extra Mural Research Support" (EMR) activities. It may be mentioned that the mechanism of EMR support is being practised in the developed country very extensively. The National Science Foundation (NSF) in the USA and National Science and Engineering Research Council of Canada (NSERC) are unique examples.

1- Total budgets available for EMR activities during 1985-90
Rs 630 Crores
= 350 M US $

2- Proposed total budgets for EMR activities during 1992-97
Rs 1970 Crores
= 700 M US $

Recognising the importance being given to R&D activities it is expected that the S&T agencies <u>will ensure the substantial enhancement in their budget to support R&D activities particularly EMR activities.</u>

The Department of Science and Technology is involved in fostering and promoting R&D activities in the country in a coordinated manner, through its SERC mechanism. This not only involves funding of carefully selected R&D projects but also ensures that they are regularly evaluated and the collective impact of supporting R&D activities has to be assured systematically. Such an assessment is needed for further justification of additional investment in R&D activities and dovetailing the output for socio-economic development of the country.

2.2 The challenge at hand in the management of R&D in India

In order to sustain competitiveness of our scientists and technologists in research and development, this has become essential to enhance the budget for research. However, in doing so, the S&T departments/organisations have to develop good answers to questions such as:

- How much should we spend on research?
- On what kind of research?
- Is the research high in quality?
- Where is the best place for the research to be done?
- Are findings reaching prospective users?
- Are existing government policies and programmes fostering a strong research community?

Such questions are hard to answer precisely. Individual perceptions differ. The politician may claim that all research must have a short term impact on society, even more so in difficult financial times. Conversely, the pure scientist may perceive this statement as a threat to his intellectual freedom. To begin with, there is no consensus on indicators of the performance of researchers, institutions or sectors. Without generally agreed methods of judging output, policy formulation occurs in a kind of fog.

2.3 Objectives of the Research Management Project

There are several questions which come to one's mind in connection with the evaluation. For example one of the most relevant question is what should we evaluate, individual scientists, R&D projects, R&D programs/schemes (SERC in this particular project) or institutions/organisations, etc. Under this project, R&D programs/schemes have been selected. The emphasis is more on basic research. Keeping the above in mind, an attempt has been made to focus on the issues related to evaluation and impact assessment of R&D programs/schemes based on Canadian experience and its relevance in Indian context.

Objectives

(i) To study the Canadian experience in evaluation and impact assessment of the R&D programs of NSERC and extract these elements relevant to the Indian context.
(ii) To look at the methods of obtaining feedback from output of research projects in order to modify the existing policies of funding.
(iii) To recommend a model approach to SERC in Indian context.

3.0 Research and Development programs

3.1 Definition of R&D

The definition of R&D used in this study is that put forth in the Frascati Manual, Organisation for Economic Co-operation and Development, 1976: "Research and experimental development comprise creative work undertaken on a systematic basis in order to increase the stock knowledge, including knowledge of mankind, culture and society, and the use of this stock of knowledge to device new applications". This report excludes Related Scientific Activities which are not directly associated with an R&D program.

Related Scientific activities are defined as those which complement and extend R&D. They are collecting, coding, recording, classifying, disseminating, translating and analyzing of data by scientific and technical personnel(except when carried out solely or primarily for the purpose of R&D), bibliographic services, patent services, scientific and technical information extension and advisory services, and scientific conferences.

3.2 Canadian involvement in R&D

There are number of ways by which the Canadian government supports R&D. In house R&D is done by the federal government in its own laboratories by its own researchers. With contracts, R&D is performed by an organization outside the department or agency which requested it. Such an organisation might be external to the government or be another department or agency within the government. A contract is a legal agreement between two or more parties which will usually specify the nature and general objective of the activity to be performed, and the provision of the corresponding results according to an agreed upon schedule and cost.

Contributions are similar to contracts in that R&D is carried on outside the department or agency that is funding it. A contribution also requires an agreement between the government and the recipient, specifying the terms and conditions under which funds will be paid to the recipient.

Grants are similar to contributions except that there is no explicit constraint on results to be achieved by the organization being funded. A grant is an unconditional payment to a recipient and government does not necessarily receive any direct services (information, goods, etc.) as a result. It is to be noted, however, that there are specific eligibility conditions which prospective recipients must meet. Perhaps the only constraint then is that the funded organization must produce results that are compatible with the general objectives of the granting department or agency; otherwise, presumably, no further grants would be forthcoming.

3.3 R&D classification

Based on the Frascati Manual, R&D may be classified into two broad categories. These categories are mission-oriented research and non-mission-oriented research. The fundamental differences between mission-oriented research and non-mission-oriented research is that with the former, research work is being done with a clear purpose in mind (e.g. pollution abatement) while for the latter it is not (e.g. astrophysics). Mission-oriented R&D programs will usually involve applied research and experimental developmental activities while non-mission-oriented programs will involve basic research (in which case it is often called pure of free research). One should note, however, that basic research can also be targeted (e.g. plasma physics where the goal is fusion power), in which case it becomes mission-oriented and should be evaluated as such.

Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view. Basic research formulates and tests hypotheses, theories or laws, thereby providing the basis for future applied research. The results of basic research are not generally marketable but are usually published in journals and circulated to interested colleagues.

Applied research is also original investigation undertaken to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective. Applied research in undertaken either to determine uses for the findings of basic research, or to determine new methods or ways of achieving some specific and pre-determined objectives. The distinction between basic and applied research will often be marked by the creation of a new project to explore any promising results of a basic research program.

Experimental development is systematic work, drawing on existing knowledge gained from research or practical experience, or both, that is directed to producing new materials, products or devices, to installing new processes, systems and services, or to improving substantially those already produced or installed.

3.4 R&D in Indian Context

India has a long and distinguished tradition in R&D. After adopting the Science Policy Resolution on the 4th of March 1958, there was substantial increase in the national expenditure on R&D. (Rs 121.4 Crores (1955-56) to Rs 3471.81 Crores (1988-89). The goal of R&D evolved in the following phases:

(i) Creation of infrastructure for research;
(ii) Promotion of research aimed at import substitution;
(iii) Export promotion and to solve the economic problems of the country;
(iv) Attainment of self-reliance;
(v) Science for the people;
(vi) Promotion of basic research and international impact.

There are several government agencies/departments including socio-economic Ministries/Departments such as Indian Council of Agricultural Research (ICAR), Indian Council of Medical Research (ICMR), Council of Scientific and Industrial Research (CSIR), Department of Atomic Energy (DAE), Department of Environment (DOEn), Department of Biotechnology (DBT), Department of Coal etc. These organisations are supporting R&D programs related to their specific mandate to see the overall growth of these areas. In addition, University Grants Commission (UGC) and the Ministry of Education also provide major support for R&D activities.

The national expenditure on R&D and its relation to GNP for selected years is attached as Annexure II. The Extra-mural R&D budgets (EMR) of S&T agencies for the 7th and 8th five plan is attached as Annexure III.

At present there are 130 specialised laboratories and institutions which are engaged in R&D activities under the aegis of these government agencies/Ministries. In addition 150 universities are also involved in R&D activities. Over 900 in-house R&D units under public and private sectors are also doing R&D to meet their own needs.

Department of Science and Technology (DST) has a unique responsibility of promoting S&T activities in the country. On the one hand, it has the mandate to ensure coordination of areas of S&T involving various institutions and evolve policy measures and on the other hand certain specific programmes and projects related to the strengthening of R&D in selected areas.

The Science and Engineering Research Council (SERC) has been helping the DST to identify emerging areas of research for support for basic sciences and engineering around outstanding individuals as well as in establishing major facilities and evolving national programmes.

NATIONAL EXPENDITURE ON RESEARCH & DEVELOPMENT AND ITS RELATION TO GNP FOR SELECTED YEARS

(Crores of Rupees)

Particulars	1958-59	1965-66	1970-71	1975-76	1980-81	1985-86	1986-87	1988-89
At Current Prices								
GNP at factor cost	13231	23899	39424	70946	122571	@232730	@258637	*346277
Expenditure on R&D	22.93	68.39	139.64	356.71	760.52	2068.78	2495.87	3471.81
Expenditure on R&D as percentage of GNP	0.17	0.29	0.35	0.50	0.62	0.89	0.96	1.00
At Constant Prices (Base 1980-81)								
GNP at factor cost	57311	71338	89465	104660	122571	@156147	@162188	*186143
Expenditure on R&D	99.32	204.14	316.89	526.22	760.52	1388.02	1565.13	1866.29
Expenditure on R&D as percentage of GNP	0.17	0.29	0.35	0.50	0.62	0.89	0.96	1.00

SOURCE:
1. Department of Science & Technology
2. Economic Survey 1989-90

NOTE:
1. 1 Crore = 10 Millions
2. For working out constant prices, GNP price deflators as per Economic Survey 1989-90 have been used.
3. @ Provisional
4. * Quick Estimate

Annexure III

Extra-mural R&D budgets of S&T Agencies for the 7th & 8th Plan Period (PLAN) (Rs in Lakhs)

Sr. No.	Agency/ Depts.	Scheme (s)	Actual Exp. during 7th plan 1985-90	Proposed Outlay during 8th plan 1990-95	Actual Exp. during 1990-91	Budget Provision during 1991-92
1.	DST	SERC + IRHPA	7035	11500	1735	1850
2.	DBT	R&D Schemes	10550	52800[1]	4028	5580
3.	DSIR/ CSIR	General & Emeritus Schemes	2098	3500	720	750
4.	DAE	BRNS	808	4426	289	385
5.	DOS	RESPOND+STCs	340	1100	84	164
6.	DOD	MRDF	210.11	1700	129.16	300
7.	DRDO[2]	General Schemes+Res. & Training (Electronics)+ARDB Grant-in-aid	2448.84	3475	574.5	623
8.	DOE	TDC, NRC, EMDC CAD 9222 & Other Plan Progs.	9222	58851	2705	2900
9.	DOEn	R&D Including Action Programmes	2131	4120	329	350
10.	DNES	R&D	5060.73	8483.6	1180.6[3]	1366
11.	ICAR	Adhoc CESS Schemes	3538.37	6018.0	990.89	591.55
12.	ICMR	Extramural	6615.73	12630.0	1304.52	1489.0
13.	UGC	$$$	12634.00	25315.0	3965.0	4582.0
14.	DOEd	R&D	354.30[4]	3000.0[5]	200.00	350.0
	Total		63046.08 (US$ 29M)	196918.60 (US$ 82M)	18234.67 (US$ 7M)	21280.55 (US$ 8M)

1 To be revised.

2 All defence outlays are under Non-Plan.

3 Actual figure not available. Figures on the basis of RE.

$$$ SAP, COSIST, NSC, IUCAA, Inter University Consortium, Fellowships, Projects, USICs, Career Awards, Research Scientists, Superconductivity.

4 Scheme started in 1987 only.

5 May be revised.

4.0 Issues involved in evaluation of Canadian R&D programs[1]

4.1 Mission-oriented R&D Program

The mission-oriented R&D program evaluation issues are regrouped into five main categories:

4.1.1 Program Rationale issues
4.1.2 Client relevance
4.1.3 Program management
4.1.4 Program outcomes
4.1.5 Program alternatives

4.1.1 Program Rational issues

4.1.1.1 Program Legitimacy

- Do the research activities undertaken by the R&D program constitute a legitimate role for government at this time?

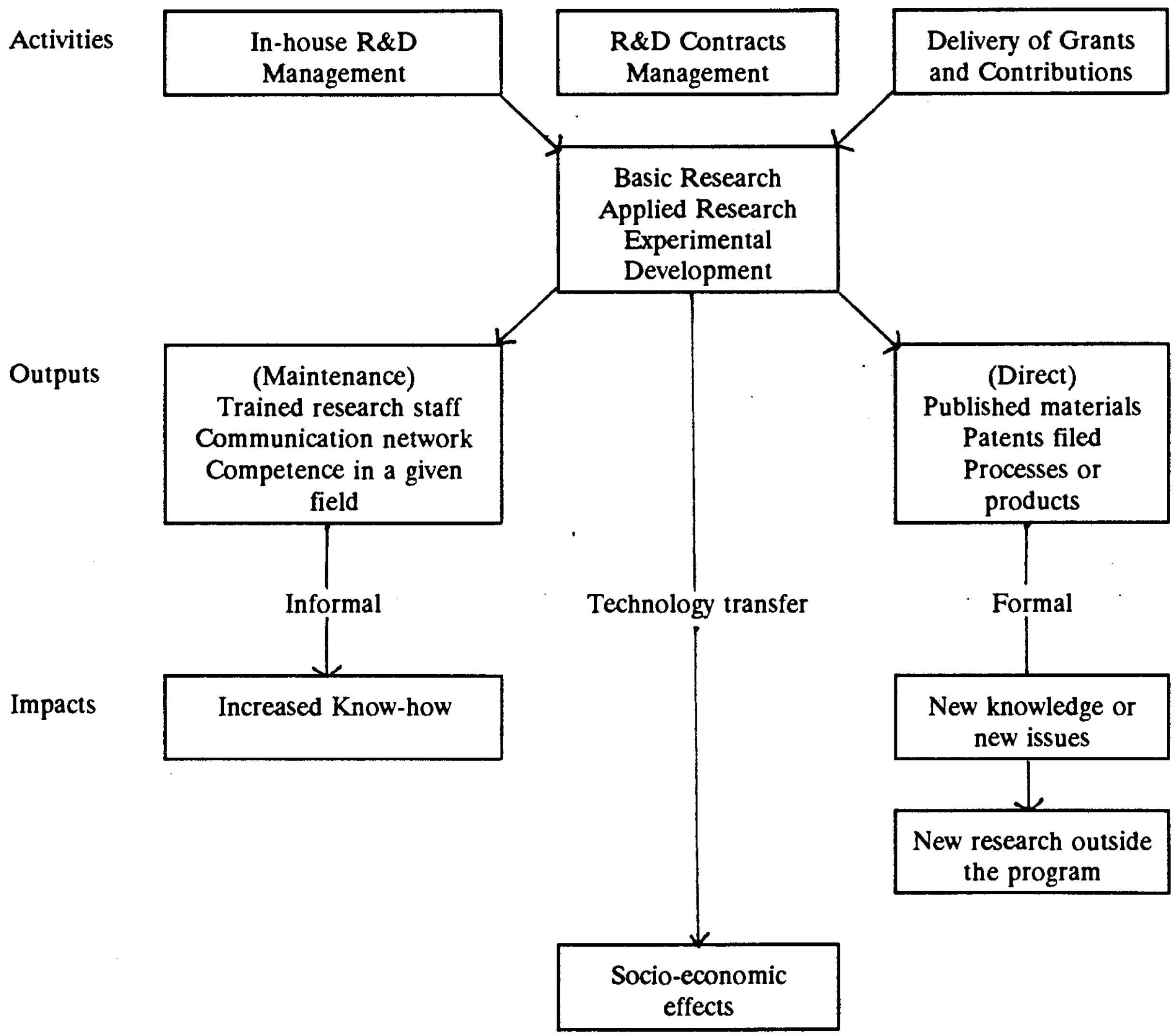
4.1.1.2 Program Relevance

- Do the conditions that gave rise to the program still prevail today?
- Are the objectives of the R&D program consistent with the current government policy priorities and goals?
- Does the R&D program fit into a well defined innovation process?
- Does the R&D program fit properly within the overall government programming framework?

[1] Report on Evaluation of R&D Programs; Office of the Comptroller General

4.1.1.3 Program Structure

For an R&D program to be effective, its internal structure must be sound: a generic model for R&D programs is given below.



Is the R&D program design and mix of research activities and outputs such that it is reasonable and probable to expect that substantial benefits will accrue from the program?

4.1.2 Client Relevance issue

- To what extent are the various clients or users satisfied that the program is producing or is likely to produce R&D results which will be useful to them?

4.1.3 Program Management issues

- Is the level and distribution of resources for the R&D program adequate?
- Is the size, structure and organization of the R&D program suitable?
- Is the management style appropriate to the particular R&D environment?
- Has the element of risk been adequately considered in decision making concerning the program delivery?

4.1.4 Outcome issues

- Has the R&D program met its objectives in terms of cost, timeliness and results anticipated?
- What have been or are expected to be the broad impacts and effects (both positive or negative)?
- Is the quality of research done adequate?

4.2 Evaluation Issues for Non-Mission-Oriented R&D Programs

Unlike mission-oriented R&D programs which operate within the context of a clear purpose, non-mission-oriented programs have no such clear purpose other than the general advancement of man's knowledge of the universe. Accordingly, many of the program evaluation issues discussed earlier will not apply here in particular program legitimacy and program relevance: further client relevance is also not an issue. However, a number of issues, such as program management issues program outcome issues etc. can be important when evaluating a non-mission-oriented R&D program.

4.2.1 Program Structures and Management Issues

Non-mission-oriented R&D programs are usually granting programs where funds are given to organizations outside government (usually academic institutions) to carry out basic research. How this process of allocating funds works will be critical to the overall effectiveness of the program. Thus, a legitimate issue is:

- Is the program designed and managed in such a way that it is reasonable to expect that substantial high quality research will accrue form the program?

In this context a review of the selection process is essential. Accordingly, review should focus on the merit and application of the selection criteria. Furthermore, management issues are relevant in cases where the non-mission-oriented R&D is being done in-house. Then the questions of management style, level and distribution of resources and organization of R&D program can be exceedingly important.

4.2.2 Program Outcome Issues

There are two main outcomes for non-mission-oriented programs:

- Quality of research
- Training of research scientists

The ultimate impacts and effects of basic research are in most cases impossible to assess. However, there are some measures of the quality of the research and number of scientists trained. Hence, the evaluation question here can be:

- Is the program resulting in high quality research and highly trained research scientists?

4.2.2.1 Quality of Research

In determining the quality of the research produced, the evaluator faces a number of possible approaches, all of which have been tried with more or less success. They are:

- Evaluating by means of peer review the contribution the R&D program is making to scientific or technical knowledge.
- Counting the number of publications associated with the program which have been accepted in refereed journals or conference proceedings.
- Counting the number of citations made of research work undertaken by the program.
- Counting the number of awards or honours the program's laboratory or its professional staff received.
- Counting the number of technical reports produced by the program.
- Counting the number of patents filed or disclosed by the program.

These approaches are described below along with a brief discussion of their respective advantages and disadvantages. In one way or another they all address the question - Is the R&D program producing quality research?

4.2.2.2 Peer Review

Peer review has been considered to be a valuable method in evaluating the quality of research. It is a basic part of the Natural Sciences and Engineering Research Council's granting process where it is well respected and highly regarded. And the National Research Council has used a well-developed peer review committee system to assess the quality and promise of its research and service activities over more than a decade. However, there are some obvious problems with peer review. Some of these are:

- identifying knowledgeable peers who are willing to act as reviewers;
- making sure that the selected peers have no conflict of interest; (e.g. receive grants from the program, co-author papers with R&D program professionals or have interpersonal relationships with them);
- presenting information to the reviewers in such a way that inter-rater agreement is high; or differences can be readily understood;
- developing a suitable rating instrument; and,
- ensuring confidentiality.

A multi-criteria approach to peer evaluation appears to be the route taken by several studies. Some of the factors which could be used by a peer to rate published articles or reports are:

- overall research quality;
- raising of important theoretical issues;
- contribution of an important method;
- resolving a recognized controversy;
- contribution of important data;
- leading the field in an appropriate direction; and,
- provision of new ideas for other investigators.

Peer review committees are usually inexpensive, the services of the committee members often being free. They should certainly be considered when measuring the quality of R&D, but only in conjunction with some other methods such as the number of publications, citations, etc. The National Science Foundation of the U.S.A. defended with success in front of Congress the peer review system for the evaluation of research and development.

4.2.2.3 Number of Publications

One common technique for judging the performance of an R&D program is to simply count the number of papers produced during the life of the program or during some given period. While a relatively easy procedure, if used by itself it has some important drawbacks which reduce its effectiveness as a valid technique.

Some of the most important drawbacks are:

- the "counts" do not usually take into consideration the rating of the various journals involved;
- the "counts" reflect quantity (which can be artificially increased) more than quality;
- even the "counts" may be misleading due to multiple articles in different journals or conference proceedings about the same work;
- in some disciplines, especially new ones, the communication of scientific or technical information may not be done via journals, articles, etc.; and,
- some employers actively discourage open literature publication for reasons of either commercial or military secrecy.

In one examination of the use of publications as a measurement criteria for the quality of R&D, Frame considers that before an evaluator can begin to collect and analyze data, he or she must answer a number of fundamental questions:

- What publications are to be included in the evaluation? Only journal articles? Monographs? Research reports? Conference proceedings? Some combination of these?
- What data sources should be used? Self-reporting form scientists or engineers? Abstracts or citation indexes, or both? Journals?
- What time period should be examined? What time lags should be used to take into account that time elapses between doing the research work and getting it published?
- Should only publications that are directly associated with the objectives or field of study of the program be included?
- Have the wide variations in publication rates from discipline to discipline been taken into account?
- What control group is most suitable to use for baseline comparisons? Is the data on the control group readily available or does it have to be developed?

Publications as an indicator of performance are only valid in laboratories where one of the objectives is to contribute to scientific knowledge. In an applied R&D program, criteria which measure the application of science to new products or processes should be more important and more in line with objectives. In the federal government this is not often done because performance is usually measured using publications as an indicator. In many cases the successful application of science would be a more appropriate measure.

The long time delays required for publications and the advent of computer network telecommunication is bound to change the pattern whereby scientific knowledge gets disseminated. With time, publications will probably become less and less important as an indicator of the quality of R&D work.

4.2.2.4 Citation Analysis

A modification of publication counts is the use of citation analysis techniques. There are also several drawbacks to using citations as a measure of R&D quality. Among the distorting influences affecting the use of citation measures are:

- the inability to cite the output of secret military and commercially proprietary industrial research;
- the reliance upon personal communication, rather than on formal communications channels (e.g. reports or articles) for the exchange and transfer of technical information;
- the repetition of similar articles by the same author(s) to present the same findings;
- the excessive citations of associate investigators (the "I'll cite you and you cite me" routine);
- the differences between fields in their citation behaviour and publishing practices;
- the habit of self-citation;
- the fact that only the first author of a multi-author paper is used in the citation system;
- the variations in how much emphasis is devoted to disseminating the research;
- the variation in how extensively the article submitted to a journal is refereed; and,
- the variation in the rating of the journals.

Martin and Irvine note the following as additional problems in using citation analysis:

- authors with identical names;
- clerical errors in preparing the citation index;
- incomplete coverage of journals;
- "Halo effect" citations (citing a well-known author);
- variation of citation rate of a paper due to either initially unrecognized advances, or integration of the major advance into the pool of common knowledge; and,
- critical citations, that is, citing authors for their poor research or the unreliability of their findings.

Citation measures cannot be employed properly until several years after the publication of research findings because of the substantial time lags involved in publication. This delay is also one factor which has led to the growth of technical reports, the appearance of "shadow" or "grey" literature, and to more reliance on computer communication networks. Because of the time delay, citation measures should only be applied to longer term R&D programs. Furthermore, the number of citations versus time will also be indicative of the quality of the research being cited. A sharp rate of rise in the number of citations followed by a steady rate of citations being viewed as good, whereas a sharp rise and fall could be viewed with suspicion.

4.2.2.5 Number of Awards and Honours

Another indicator of R&D program performance is the prestige of the R&D program as seen by outside organizations. A measure of this prestige is the awards which the professional staff receive from their scientific or professional societies. Some organizations use such factors as staff elected to national academies and staff invited to sit on government committees as indicators of R&D program quality. This evaluation method is basically a form of peer review with the evaluators being drawn from beyond the immediate boundaries of the scientific or technical discipline covered by the R&D program.

Since these indicators are more closely tied to the evaluation of individual scientists or engineers, they can suffer from two problems the "Halo Effect" or the "Matthew Effect". For example, a group considering a candidate for an award, may consider the past performance of the person or programs, and not necessarily current performance.

These indicators should definitely be used in conjunction with other more direct indicators such as peer reviews or citation analyses.

4.2.2.6 Number of Technical Reports

In organizations where restrictions on publication in the open literature exist, it is felt that the counting of internal technical reports is a suitable substitute. Again, as in the case of publications in the open literature, the number of technical reports is more a measure of quantity than quality of R&D output. Furthermore, emphasis on only the number of reports in a given time period could encourage the professional to produce several "hack" pieces rather than one solid, high quality report. The breath of the distribution and demand for the report should therefore also be taken into consideration.

4.2.2.7 Number of Patents

Patent counts and patent statistics have also been used as an indicator of research output. However, this measure has many limitations for the measurement of the output of R&D. Inventions may not be reflected in a patent statistic because as Salasin, Hattery, and Ramsay point out:

- the inventors may perceive the inventions lack of commercial application;
- the propensity to patent varies with the ease with which the technical advance can be copied;
- the inventors may believe that there is a greater secrecy if a patent is not obtained;
- the rate of change of technology may be so fast that a patent would not provide any economic advantage;
- some inventions are not patentable;

- the inventors may be more concerned with scientific and technical leadership than patent protection;
- the existence of legal factors is seen as blocking the obtainment of a patent; financial consideration may also affect the patent rate;
- patents do not generally reflect the applied research and inventive activity of the federal government where the propensity to patent is much lower.

Some of the problems with patent counts as a measure of R&D output are: quality variations in patents that are not reflected in patent statistics, and patents which pertain primarily to developmental efforts.

Evaluators are encouraged to bear in mind the pros and cons of each approach and to select an overall approach based on multiple lines of evidence which takes the strengths and weaknesses of each approach into account.

It must be clearly recognized, however, that addressing the issue of the quality of research can only lead to marginal changes (i.e. more or less research, or higher or lower quality research). The significant potential for change lies with an examination of the program legitimacy and relevance issues. Accordingly, only the appropriate amount of "evaluation" resources should be directed to the issues of the quality of research of an R&D program.

5.0 Case studies of Natural Science and Engineering Research Council (NSERC) of Canada research support

NSERC is the largest granting council in Canada which is promoting research in the areas of natural sciences and engineering in the Canadian universities. It has two major important programs, namely "Operating Research Grant" and "Strategic Grant". The objectives of the operating research grant are to foster excellence in research in the universities and to provide a stimulating environment for research training. However, the objectives of Strategic Grant are to provide support for initiation or acceleration of substantial projects in certain areas of national concern.

Objectives of SERC in Indian context:

i) To promote research in newly emerging and front line areas of science and engineering including multi-disciplinary fields.

ii) To selectively promote general research capability in relevant areas of science and engineering taking into account existing research capabilities of the host institution.

iii) To encourage young scientists to take up challenging research and development activities.

SERC is supporting research in carefully selected areas of science and engineering called "Challenging Areas". By and large, the focus of SERC support is towards "Basic Research". Seventy percent of its funds go to academic sectors such as universities or colleges.

In view of the above, it was felt appropriate to study the above two programs of NSERC Canada in detail and also the contents of evaluation reports of these two programs. While studying the contents of evaluation reports, the emphasis was given to finding out the

- overall purpose of evaluation;
- data source, findings and recommendations

In order to understand the issues and methodologies involved in the evaluation process, the following sections (5.1 and 5.2) have been taken from the "Evaluation Reports on Operating Research Grant and Strategic Grant of NSERC".

5.1 Evaluation of the NSERC Operating Grants Program

The Operating Grants Program of NSERC provides grants to academic staff members of Canadian universities to support on-going programs of research in science and engineering. It is the Canadian government 's main program for supporting university research in science and engineering.

The overall objective of the program is "to assist in the promotion and maintenance of a diverse and high quality research capability in the natural sciences and engineering in Canadian universities". It has two sub-objectives:

- "To foster research excellence" (which is interpreted to mean the production of high quality and significant research results).
- "To provide a stimulating environment for research training" (i.e. the program is intended to support the training of additional researchers).

The program is by far NSERC's largest program, and it consumes about half of the total NSERC budget. This program has very broad coverage - most faculty members are from science and engineering in Canada who are actively carrying out research have operating grants as long as they remain productive and competitive. Most operating grants run for three years.

The overall purpose of the evaluation is:

- To what extent is the program meeting its objectives?
- What are the other impacts of the program, both intended and unintended?
- How well is the program delivery process working and are there ways in which it could be improved?

Issues related to Program impacts:

1- What is the current level of research capability in science and engineering at Canadian universities, and what is the impact of the program on the level of research capability?
2- To what degree are high quality research results produced and what is the impact of the program on the quantity and quality of research results?
3- To what degree are highly qualified researchers produced and what is the impact of the program on the quantity and quality of highly trained researchers?
4- What is the effect of the program in enabling young researchers to further develop their expertise?
5- How have the amount of funding available from the program and the amount of support available from universities affected the attainment of the program's objectives?
6- To what extent have Canadian industry and government benefitted from the program - as a result of access to capable researchers and the provision of research results and trained graduate students?

Issues Related to Program Delivery

1. Is the program still not sufficiently selective in some discipline or, alternatively, are there indications that the program currently may be too selective in some disciplines?
2. To what extent has selectivity and an emphasis on excellence resulted in negative impacts on research capability, output, or training?
3. Are the selection criteria for grant applications appropriate and are they being appropriately evaluated?
4. How well is the peer review process working?
5. Does the program provide an appropriate degree of support for innovation and high risk research, and interdisciplinary research?
6. Are there ways in which the program delivery process could be improved?

Study Design:

1. Data Collection Activities

The main data collection activities carried out during the study are briefly described below.

1. NSERC data and publications.
2. External data sources (for Canada, the primary data sources were Statistics Canada publications).
3. Review of bibliometric studies.
4. Survey of Operating Grant recipients.
5. Survey of unsuccessful applicants.
6. Survey of department heads/chairman.
7. Survey of deans of Science and Engineering faculties.
8. Survey of Grants Selection Committee members.
9. Survey of Group chairman.
10. Survey of researchers in other countries.
11. Survey of industry officials.
12. Survey of government officials.
13. Field visit to universities.

2. Possible Criticisms of the Evaluation Study

1. Lack of coverage of the basic program rationale issue.
2. Marginal coverage of the main program objectives issues.
3. No critical assessment of the peer review process.
4. Heavy reliance on data obtained from the research community.
5. Lack of totally definitive answers for many issues.

Weighted Rating of the Quality of Research

First respondents were asked to rate the quality of research at Canadian universities (in their discipline or relevant disciplines) on an absolute scale. The results are shown in the following table. The right hand column is a weighted rating for each category of respondent:

5 x (% who answered "World class") + 4 x (% who answered "Many important results") + ... + 1 x (% who answered "Generally unimportant results")

Members of the Canadian academic community clearly have higher opinions of Canadian research quality than the other respondents. Also, within the academic community - except for the unsuccessful -opinions are progressively more negative as one moves up the administrative ladder. Industry and government officials have a much more negative view of the quality of Canadian research than the academic community.

Rating of the quality of research in your discipline(s) at Canadian universities (% of responses for each answer)						
	Generally unimportant results (1)	Some good results (2)	Some important results (3)	Many important results (4)	World class (5)	Weighted rating
Grantees	0	4	19	30	40	425
Unsuccessful	2	6	26	32	35	395
Heads	0	5	21	35	39	408
Deans	0	3	15	53	29	408
Internationals	0	4	39	31	26	379
Industry	4	13	36	33	15	345
Government officials	0	5	56	24	15	349

.2 Evaluation of the NSERC Strategic Grants Program

The Strategic Grants Program provides grants to academic staff members of Canadian universities to support scientific and engineering research in certain specified areas.

The overall objective of the program is "to provide support for the initiation or acceleration of substantial projects or programs in certain areas of national concern."

NSERC's Award Guide provides the following elaboration of this objective:

"The aim of this program is to enable university researchers to make greater contributions than in the past towards the understanding or solution of problems of national concern through specific applied research having potential for relatively short-term socio-economic benefits or through more basic research designed to develop knowledge in areas of socio-economic importance."

The following areas were identified for support:

- Biotechnology
- Communications and computers
- Energy
- Environmental toxicology
- Food and Agriculture
- Industrial materials and processes
- Oceans

In addition there is an open area which provides an opportunity for researchers to submit proposals for research projects which they feel are related to problems of national concern but which do not fall within any of the other specified areas.

The evaluation of the Strategic Grants Program was carried out in 1987. The overall purpose of the evaluation was to determine the following:

- Is the rationale for the program still valid?
- To what extent is the program meeting its objectives?
- What are the other impacts of the program, both intended and unintended?
- How well is the program delivery process working and are there ways in which the delivery process could be improved?

Who can be funded?

Applicants for strategic grants must be academic staff members at Canadian universities. However, in the case of group grants, the co-investigators do not need to be university staff, they only need to possess equivalent qualifications.

Peer review mechanism

Applications for strategic grants are reviewed by selection panels consisting of representatives of the academic community and representatives of the industry and government. There is one panel for each of the eight research areas.

Proposals are rated using the following criteria:

- Scientific merit of the proposed research
- Excellence of the applicant(s)
- Relevance of the proposed research to the research area

Each criterion carries equal weight and only these three criteria can be used.

The third criteria "Relevance" means the degree to which the research is likely to contribute to the understanding or solution of problems of national concern.

5.2.1 Evaluation Issues

There are several issues which have been assigned a priority according to its importance in the evaluation. The definitions of the priorities are as follows:

High: It is very important that this issue or a similar issue be investigated during the evaluation. The issue is directly related to key program objectives, important intended or unintended impacts or significant restructuring of the program.

Medium: An analysis of this issue would provide important information on the operation of the program.

Low: An analysis of this issue would provide good background information on the operation of the program and some insight into modifications that may be required.

Issues that did not satisfy on of these three criteria or were judged to be inappropriate for evaluation study for some reason (e.g. clearly beyond the scope of the study) were omitted from further consideration.

The remaining issues are presented below according to the four basic categories of program evaluation issues specified by the office of the Comptroller General:

Program rationale: Does the program make sense?

Program objectives: Has the program performed as expected?

Other program impacts: What other impacts - both intended and unintended - have occurred as a result of the program?

Program delivery and program alternatives: Are there better ways of achieving the results?

Issues Related to Program Rationale

(1) **Issue:** Is there a need for a program specifically designed to encourage research in areas of national concern? In particular:

(a) What gaps -- in terms of the nature of the research supported -- are filled by the Strategic Grants program and not filled by other NSERC programs?
(b) Is it important -- in terms of the nation's socioeconomic well-being and advancement -- for NSERC to support these types of research?
(c) To what extent could other (possibly redesigned) NSERC programs provide the appropriate degree of support for these types of research?

Priority: High. This question has been much debated recently (see, e.g., the report of the Program Review Committee), it is controversial, and it underlies the very existence of the program.

(2) **Issue:** What is the appropriate balance between the degree of support for free research versus targeted research, (i.e., research restricted to certain research areas or topics), and how should this balance be determined?

Priority: Medium. The balance between free research and targeted research is inevitably controversial in a country with limited resources for research. Most interviewees felt it would be useful if the evaluation could provide a summary of the experience of other countries in dealing with this issue.

(3) **Issue:** To what extent has additional research been carried out in the specified areas as a result of the program? Specifically:

(a) How much research supported by the program has been carried out in each of the specified areas?

(b) How much of the research supported by the program would not have been carried out in the absence of the program?

(c) How much research not supported by this program has been carried out in the specified areas as a result of the program? (e.g., the program may have caused some people to redirect their research.)

Priority: High. This issue is directly related to the objective of the program. The answer to question (b) (program incrementality) is also needed to evaluate all other impacts of the program -- i.e., to determine the extent to which apparent impacts should be attributed to the program.

(4) **Issue:** To what extent have significant and/or user-relevant research contributions resulted from the program? Specifically:

(a) What is the quality of the research results (e.g., in terms of uniqueness, originality, rigour, and importance to the advancement of knowledge) that have resulted from the program?

(b) What is the relevance of the research results to the solution of high priority problems in the subject areas?

(c) What is the usefulness -- or likely usefulness -- of the research results to industry and government?

Priority: High. This issue is directly related to the objective of the program.

(5) **Issue:** Are the research areas eligible for support so broad (i.e., too many areas and/or scope of definition of the areas too broad) that the impact of the program has been significantly diluted?

Priority: High. There has been much discussion in recent years about whether the program has been spread too thin (because of the number and breadth of research areas eligible for support) and whether the program should be more proactive in identifying the high priority problems in each area. This is currently a major concern of the Strategic Grants Committee.

(6) **Issue:** To what extent have the funds available for the program affected the attainment of the program's objectives?

Priority: Medium. Because of the low success rate relative to other NSERC programs, it would be useful to document the extent to which excellent proposals have not been funded.

Issues Related to Other Program Impacts

(7) **Issue:** To what extent has research capability in the identified areas increased as a result of the program?

Priority: Medium/High. This is an important intended impact of the program. On the other hand, the main focus of the program is on outputs -- the accelerated production of research results which are of socio-economic importance -- not the building up of research capability to solve problems in the identified areas in the future.

(8) **Issue:** What has been the effect of the program on the amount of high quality group research that has been carried out and on the formation of effective research groups?

Priority: Medium. As noted under issue 7, the main focus of the program is on outputs, not on the manner in which the outputs are achieved. On the other hand, the relatively large amounts of group and multidisciplinary research that have been carried out are important features of the program which should be documented if possible. As one interviewee said: "Typical academic behaviour is to carry out safe research in your own area, working on your own. The Operating Grants program has had an impact on altering this type of behaviour, and if we think that's a significant positive impact, it should be documented."

(9) **Issue:** What has been the effect of the program on the amount of high quality multidisciplinary research that has been carried out and on the formation of effective multidisciplinary teams?

Priority: Medium. Same rationale as for issue 8.

(10) **Issue:** Have grant recipients had more involvement and interaction with industry and government (e.g., as advisers or consultants) on a continuing basis as a result of the program?

Priority: Medium. Although not the main focus of the program, a number of people interviewed felt this was a significant positive impact (if it has occurred) which should be documented -- "the type of thing Canada should be encouraging". NSERC staff noted that the degree of continuing interaction with the user community is a measure of the authenticity of the interaction which the program encourages during the application preparation process.

(11) **Issue:** What has been the role of the program in training researchers in the identified areas?

Priority: Medium. There was discrepancy between the views of NSERC staff and the non-staff members interviewed regarding the importance of this issue. Staff felt strongly that training (including the role of training in technology transfer) was an important adjunct of the program. Non-staff members generally felt that the training impact of the program was not as important as some of the other impacts and probably not worth documenting.

Issues Related to Program Delivery and Program Alternatives

(12) **Issue:** To what extent has a lack of continuity in funding caused problems for research groups that have been formed as a result of the program? Alternatively, have there been many instances in which the desire to maintain groups has affected decisions on renewal applications?

Priority: Low. There was a general consensus that this is not a major problem area, since groups that are really strong (i.e., productive researchers with excellent proposals) should be able to receive funding, unless their research area becomes less relevant to national priorities. The issue has not been eliminated because it does seem to be the cause of some concern, both among selection panels and research groups.

(13) **Issue:** Are the three official application evaluation criteria (the research project, the applicant(s), and the relevance of the proposal) appropriate and appropriately evaluated? In particular:

(a) Are these the right criteria, in view of the objectives of the program?

(b) Should they be equally weighted?

(c) Have they, in practice, been equally weighted?

(d) Have there been any special difficulties associated with evaluating these criteria?

Priority: Medium/High. There seems to be some concern about the criteria and their evaluation. For example, the concept of relevance and its application have been controversial, so it is important to address such questions as:

(a) Is there a satisfactory way of defining and evaluating relevance?

(b) Are the panels, many of whose members are university faculty members, properly constituted to be able to evaluate relevance?

There are also concerns related to the other criteria, involving such questions as:

(a) Have the application evaluation and weighting procedures resulted in less support than is appropriate for fundamental research?

(b) Are the panels, many of whose members are not university researchers, properly constituted to be able to evaluate the excellence of the researcher(s) and the scientific merit of the proposed research.

(14) **Issue:** What has been the quality and effectiveness of the application review process?

Priority: Low/Medium. Although there is some overlap between this issue and issue 13, this issue deals with the quality of the review process, while issue 13 deals with the structure of the review process. Most interviewees felt that this is not a major problem area and that the review process is as good as one could reasonably expect. Also, the most important aspect of this issue -- the question of whether the program funds poor research -- is covered under issue 4. Nevertheless, it is felt that, if there are problems with the process, they should be identified.

(15) **Issue:** To what extent are grant decisions affected by a bias toward the interests, philosophy, and background of selection panel members?

Priority: Low. There is no evidence of an unusual amount of concern about the fairness of the process. This may be due, to some extent, to the fact that the program makes more use of external referees than the Operating Grants program. The main concern of the academic community (to the extent there is any concern) is probably with "research topic bias" -- i.e., certain research topics or schools of thought being valued too little or too much. This is the main concern with the application evaluation process used in the Operating Grants program, a certain amount of "research topic bias" is built into the Strategic Grants system -- i.e., selection panel members are supposed to have strong views about what research topics are important (to the national interest), and the academic community presumably expects that all applications leading to the advancement of knowledge in a particular research area will not receive the same relevance rating.

(16) **Issue:** What has been the quality and effectiveness of the grant monitoring process?

Priority: Medium. This is an important feature of the program delivery process, and there seems to be a reasonable amount of concern that the monitoring system has not been effective -- that many researchers treat strategic grants like operating grants (i.e., no commitment to stick to the original proposal and produce the specified deliverables) and that NSERC is not tough enough in these cases, or is not able to be tough enough because they do not have sufficient information on the progress of the research.

(17) **Issue:** What have been the quality and effectiveness of the policy making mechanisms for the program?

Priority: High. This issue includes such questions as:

- How appropriate are the mandate and structure of the Strategic Grants Committee?
- Should the Council be more directly involved in policy making?
- Should other government officials or bodies be more involved in certain aspects of policy making (e.g., the identification of "areas of national concern")?

This issue is rated as high priority because the development of policies for this program (especially the identification of areas of national concern and the specification of the appropriate degree of proactivity) appears to have been an especially difficult process.

(18) **Issue:** Are there features of the program that have discouraged researchers (in the areas covered by the program) from applying?

Priority: Low. The factors mentioned by interviewees as possibly discouraging applicants were the relatively low success rate, the emphasis on relevance, and the lack of continuity. The latter two of these are key design features of the program and are unlikely to be changed. Most interviewees were not concerned about the low success rate. They felt that the majority of researchers interested in and capable of doing high quality relevant research were applying, unless they already had sufficient funds from other sources. Several interviewees said: "If a few people are discouraged from applying, so what?"

(19) **Issue:** Has the program been a cost-effective vehicle for producing significant and user-relevant research results?

Priority: High. The steering Committee and most interviewees felt that some measure of the cost-effectiveness of the program would be very useful to NSERC, to the government, and to the academic community (which, as one interviewee said, "still has not made up its mind about the program").

6.0 Relevance to Science and Engineering Research Council (SERC) in India

The previous chapters deal with the issues related to evaluation of R&D programs and assessment of quality of research. In order to understand these issues in detail, two case studies of NSERC support viz Operating Grants program and Strategic Grants program were included. These two programs of NSERC have similarities with the extra-mural R&D programs being supported by S&T organizations in India. A number of Science and Technology (S&T) agencies in the country are encouraging time-bound Research and Development (R&D) projects, either in their own organizations or by providing research grants to individual scientists located in a large number of universities, national laboratories, and other research organizations. One of the major mandates of the Department of Science and Technology is the promotion of research in newly emerging and front line areas of S&T. The Department has been promoting R&D activities through its "Science and Engineering Research Council (SERC)".

Objectives of SERC:

i) To promote research in newly emerging and front line areas of Science and Engineering including multi-disciplinary fields.

ii) To selectively promote general research capability in relevant areas of science and engineering taking into account existing research capabilities of the host institutions.

iii) To encourage young scientists to take up challenging research and development activities.

The SERC supports research programs in universities, national laboratories, colleges, IITS, and other schools of excellence. By and large, these programs are non-mission-oriented and are fundamental and basic research programs in the area of science and engineering.

Based on the NSERC case studies of the NSERC programs, it was noticed that the overall purpose of Evaluation was:

1. Is rationale of the program still valid?

2. To what extent is the program meeting its objectives?

3. What are the impacts of the program?

4. How well is the program delivery process working?

In Indian context, SERC has the budget of the order of 5 million Canadian dollars per year. It focuses on selected emerging areas of science and engineering (e.g. plasma, lasers, neurobiology, robotics, surface science, molecular biology, etc.). The program delivery system is well established and accepted by the Government scientists and policy makers in

S&T Departments. In order to take major policy decisions (objectives of SERC, priority, mission-oriented research, etc.) and to enhance the budget, the overall purpose of the evaluation of SERC program should be to see its "impact of the program on the national and international scientific scene". By and large, SERC is supporting basic research, hence to assess its impact, one may focus on the following issues:

- Research capabilities and quality in specified areas
- Training
- Young scientist
- Group research
- Multidisciplinary research
- Research results for industry

7.0 Model Approach for the Evaluation of SERC Program in Indian Context

Based on the Canadian experience, it is proposed to undertake an exercise of "SERC Research Evaluation" under the overall guidance and supervision of SERC. The SERC may be assisted by an advisory committee consisting of 10 members of whom at least 50 percent would be members of SERC. The advisory committee members would be broadly from various disciplines such as life, chemical, physical, engineering, earth and atmospheric sciences. They could meet 3 or 4 times a year. The total duration should be one year for each discipline. A flow diagram of the various committees and their responsibilities is attached as annexure III.

7.1 Rationale

The rationale of the SERC program is based on the following needs:

- To move quickly in areas that are generally perceived to be priorities or gap areas
- To address disciplines and policy issues
- To build a sound foundation for evaluation activities in the long term
- To consult the scientific community and other S&T departments and provide them up to date information on evaluation activities being undertaken by the SERC.

The thrust of the exercise should be

1) Policy-oriented and focused on the issues which are critically important to the health of Indian research particularly SERC research (discipline wise).

2) Opportunity-oriented, namely fields of research, most probably fields which are multidisciplinary or natural sciences.

Preliminary work involved the evaluation of SERC program

- Identification of past and current evaluation activities of SERC. This will be concerned to identify data bases and where appropriate, establish mechanisms for information exchange (For instance, between national research laboratories, IITs, universities, IISC, etc.).

- Selective review of evaluation activities in other countries (in this particular case Canadian experience).

- Summary of past and current relevant literature concerning health of various research areas.

- Convene a workshop of researchers, research managers to develop consensus on research performance indicators.

Objectives of the proposed model:

- Focus on basic research;

- Analyze the structure of basic research in Indian context;

- Assess impact of basic research supported by the SERC in two or three carefully selected disciplines in terms of international research activities;

- Consider the issues of multi-agency funding mechanism.

Methodologies and outputs:

There may be the following steps in the evaluation of a discipline:

(i) Identification of key institutions and research teams (important Indian contributors to research in the area and its listing)

(ii) Historical analysis (need of setting SERC, its objectives, identification of thrust areas, SERC Young Scientists Programs, unit, training program, etc.). To what extent have SERC priorities or the interest of individual scientists encouraged the development of capability?

(iii) Bibliometric evaluation.
The purpose of bibliolmetric evaluation is to generate information on strengths in an area of scientific and scholarly research. Output from bibliometric evaluation would consist of descriptions of evident strengths, weaknesses of Indian research in a particular field and the SERC contributions.

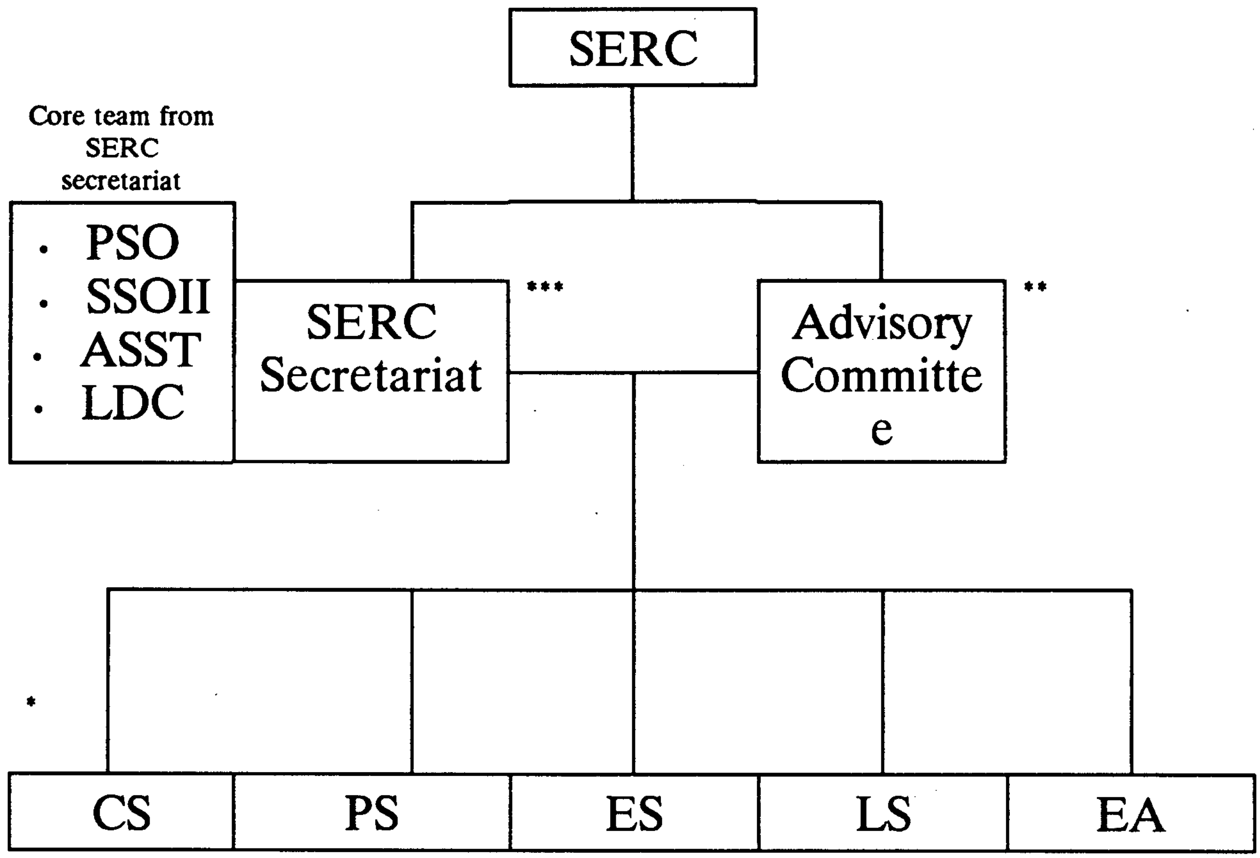
(iv) Peer review.
This is the most important component of research evaluation. After listing the research teams and institutions, then based on feedback from the community and findings in the bibliometric evaluation, advisory committee may visit the appropriate sites, with at least one international peer involved (criteria for review would include evaluation of the quality of the science, standards of experimental and research practice, future research capability, etc.). Output from the peer review would be concentrated on

- identification of requirements for strengthening and complementing capabilities at centres where outstanding research is being done;
- identification of possible sites for creating capabilities;
- policy matters.

(v) Report.
The overall responsibility of evaluation lies with the SERC. On completion of a study by the respective sub-groups, findings and recommendations may be communicated to Advisory Committee which will report to SERC and to Government. Finally for future directions/planning. This report may be called "Quality of SERC research and future directions".

Initially, the above proposed model of evaluation may be tried for one of the disciplines of Natural Sciences.

SUGGESTED MODEL FOR DISCIPLINE EVALUATION OF SERC (IMPACT ASSESSMENT)



* Sub groups:

6 members + 2 professionals
(experts) (PVT consultants/professional bodies)

Responsibilities:

- Identification of key institutions and team workers
- Historical analysis screening
- Bibliometric analysis
- Peer review mechanism

May meet 4 times in a year

** Provide guidelines to sub groups (e.g. what is to be done, why to be done, how to be done, expected output etc.)

May meet 2 times in a year

*** To provide secretarial support to sub groups/advisory committees.

Problems in implementing the model

The following problems are anticipated in implementing the proposed model.

- Expertise within the SERC Sectt/DST
- Time factor in implementation
- Financial resources
- Reservations by scientific community
- Communication gaps