Problems faced by R&D managers in Canadian federal government laboratories

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Abstract

The paper conducts a critical review of the problems faced by middle to first-line managers in managing R&D in Canadian government laboratories. The data come from the published literature, interviews with R&D managers, and information obtained from government employees undergoing training as R&D managers.

The problems are numerous and serious. They arise from a multiplicity of causes related to underfunding and bureaucratic management practices that do not allow for the special nature of R&D. Hiring freezes, staff reductions, travel restrictions and reductions in training budgets are all consequences of underfunding, resulting in an aging workforce and technological obsolescence. Bureaucratic administration rules set by central agencies constrain the freedom of R&D managers to manage effectively, and limit low-level participation in policy-making and planning. The result is that too many management posts are filled by under-achieving scientists and engineers, with resultant consequences for originality and efficiency.

The authors believe that the only cure is to undertake proper funding, recognise the special operational needs of R&D management, and select managers for managerial ability in addition to technical competence.

Research and development expenditures in Canada are characterized by a relatively low level of investment. During the 1980s, Canadian expenditure on research and development as a percentage of Gross Domestic Product has ranged between 1.15% and 1.36%. Although this is an improvement over expenditures on R&D in the 1970s, when gross national expenditure on R&D dipped below 1% of GDP, it is still approximately half of the expenditures on R&D of countries such as the US, Japan, and Germany, Canada's major economic competitors.

Another feature of Canada's research and development activities is that the level of R&D conducted in federal government laboratories is a significant percentage of Canada's total R&D effort. Table 1 shows the percentage of R&D performed in the business, government, and higher education sectors in some OECD countries in 1983 (OECD, 1986).

Table 1 1983 gross expenditure on R&D performed in various sectors as percentage of total gross expenditure on R&D in each country (includes social science activities).

	Business	Government	University
United States	71.3	12.3	13.4
Germany	70.7	13.2	15.6
Japan	63.5	9.6	23.0
United Kingdom	61.0	22.1	13.8
Italy	57.1	23.6	19.3
Canada	47.6	26.6	24.7

Of the total R&D conducted in Canada in 1983, 52.1% was publicly funded and 38.6% was funded by the business sector. Comparative figures for the US are 49.2% and 48.1%; for the UK, 50.2% and 42.1%; and for Japan, 24.0% and 65.2%.

Canadian government research and development is conducted in over 200 federal government laboratories which are scattered across the country. Laboratory sizes range from the large National Research Council of Canada laboratory complex in Ottawa and the Chalk River Nuclear Laboratories in Chalk River, Ontario both of which employ several thousand people, to small laboratories such as agricultural research stations in the prairie provinces which may employ under ten people. In total, there are approximately 6,000 scientists and engineers, assisted by 11,000 support staff. In 1986, the total annual budget for federal government laboratories was approximately $1.35 billion, or 21% of the total natural sciences and engineering R&D conducted in Canada.

Government laboratories serve different functions, ranging from research in support of regulatory and inspection functions to basic research, in order to meet the needs of different clientele. The scientific activities can be categorized by sector or by function (Bhaneja, 1980). Sectoral activities are linked to different economic bases, such as industry, agriculture, and forestry. The Department of Fisheries and Oceans, for example, has laboratories in the Atlantic provinces, central Canada, and the west coast that serve the specific needs of the local fishing industries. Functional responsibilities include regulatory activities, technology transfer, and resource management.

Despite the differences in their mandates, however, all the laboratories have, or should have, one requirement in common; effective management to enable them to fulfill their individual mandates or objectives in a timely and cost effective manner. The ability of departments to achieve these objectives is to a great extent determined by the administrative procedures, policies, and management guidelines which are set by two central senior management departments located in Ottawa. One, the Treasury Board of Canada, authorizes departmental financial expenditures and issues administrative and managerial guidelines for the on-going operation of government departments. The other, the Public Service Commission of Canada, sets forth the personnel procedures and policies that all government departments must follow.

This paper reviews some of the problems that middle to lower level government R&D managers face in trying to manage research and development activities effectively within the working environment in Canadian government departments and agencies.

Information was obtained through a review of the few studies on management of research and development in the federal government, from interviews with R&D managers in government laboratories, and from data collected during the presentation of R&D management courses over the past ten years by Stargate Consultants Limited to over 200 scientists and engineers employed in government laboratories. Comments from government scientists who have reviewed an early draft of this paper have also been incorporated.

LITERATURE REVIEW

Role of the R&D Manager

R&D managers must be concerned not only with the technical activities of their laboratories but also with the organizational context within which the work is conducted. The various activities that make up the effective R&D manager's total role involve the use of interpersonal, technical, and administrative skills (Badaway, 1982).

The following list of sub-roles of an R&D manager was compiled from the R&D management literature (Clarke, 1981). Some of the activities involved with the various roles are noted.

Technical Leader

— at the lower levels of the managerial hierarchy provides technical direction, makes operational technical decisions and suggests approaches to solving technical problems.

Communications Facilitator

— maintains a healthy flow of clear communication between the R&D group and the rest of the organization, and encourages the exchange of ideas among individuals and groups.

— is a communications link between subordinate staff and senior management and is a source of timely and accurate information.

Salesperson

— must be able to sell senior management on the technical expertise of the R&D group, and be prepared to champion good ideas generated by the group.

— must sell technical staff on the goals and objectives of senior management.

Coupling Agent

— provides a link between the world of science or engineering and the world of business or government. The R&D manager must interpret the objectives and strategies of the organization and put them into terms which are understandable by R&D personnel and must also present the views and demands of the R&D group in terms that will be understandable by senior management.

— converts the long range R&D goals of the organization into day-to-day work plans.

Goal Setter

— plays an active role in countering the tendency of nontechnical managers in the organization to consider only short-term benefits or to undertake only low risk research and development activities.

— sets goals and objectives which will stretch the abilities of their staff and result in increased laboratory capability.

Performance Motivator

— works to create an environment within the R&D group that is supportive of creativity and productivity, and is professionally stimulating.

Evaluator

— is a key individual in the evaluation of research proposals, personnel performance and total laboratory performance.

Protector

— is the first line of defence against either unwarranted criticism or unreasonable demands by other parts of the organization.

Career Coach

— encourages the R&D group to grow professionally in line with both organizational and personal needs to avoid technological obsolescence.

Politician

— the R&D manager must be able to play the organization's political games in order to win the resources required to maintain the R&D group's effectiveness, and to protect resources already controlled by the group.

Administrator

— attends to all of the various administrative demands, including the unavoidable paperwork, associated with managing people in an organizational context.

The degree to which a conscientious R&D manager can fulfill these sub-roles depends on the resources available, organizational rules, regulations, and procedures, and external environmental factors such as labour legislation and affirmative action programmes.

Ideally, organizational procedures and regulations should be designed to motivate employees and enhance productivity. Where centralized regulatory bodies, such as the Treasury Board and the Public Service Commission, set forth procedures that must be followed by all government departments and agencies, some of the procedures are inevitably inappropriate for an R&D laboratory setting. Strict adherence to poorly thought out organizational procedures and regulations can reduce the R&D manager's ability to respond to the legitimate requirements of a situation. This study identifies some of the factors that restrict a manager's ability to fulfil the many sub-roles of an effective R&D manager.

Previous Canadian Studies

In 1983, the Professional Institute of the

Public Service of Canada (PIPSC), conducted a major review of 'the critical problems which impede the effectiveness and productivity of research and development within the Public Service as they are perceived by the scientists themselves' (PIPSC, 1983). PIPSC reported that the federal government environment provided inadequate support in the areas of:

- sufficient and stable financial support
- sufficient professional personnel together with technical support staff
- creative career development and adequate opportunities to exchange ideas and discoveries
- effective science management.

Since the PIPSC report was written the situation with respect to the level of funding for intramural R&D has worsened. The budgets of many science-based departments and agencies were reduced in 1984/85 by the new Conservative federal government. The National Research Council of Canada, for example had approximately $75 million cut from its budget. The observations made in the PIPSC report are therefore even more relevant today.

On the subject of 'effective science management', the PIPSC report states that government scientists are virtually unanimous in their agreement that good quality R&D management is not the norm in intramural R&D. The government scientists 'feel strongly that management in public service laboratories generally fails to act in a fashion which recognizes and effectively mobilizes the talents and creativity of scientific staff'.

The report also states that, 'Many, if not most managerial failures, can be traced ultimately to the impact of central agency policies which seek to treat scientific programmes as equivalent to other public undertakings, liable to precisely the same tools of administrative and managerial control. The central agency regulator characteristically imposes on departmental management a set of reporting and evaluation mechanisms which focus on input-output efficiency suitable to the delivery of relatively routine services over a set budgetary timeframe.' Scientists and engineers, however, are engaged in activities where output is not certain, and where evaluation of the output can sometimes only be done over a long period. 'Where the senior administrator insists that scientists conform to standardized procedures rather than adapt his tools of management to suit the R&D context, it is hardly surprising that a lack of empathy between scientists and management results' (PIPSC, 1983).

Another problem identified in the PIPSC report was 'pernicious over-administration' which forces the working level scientist to spend increasing amounts of time on administrative detail concerned with staffing, job classification, contract proposal evaluation, and purchasing. The Report of the White House Science Council reviewing the operations of major US federal laboratories noted that this type of 'micromanagement' seriously impaired R&D performance in some laboratories (Packard, 1983).

The PIPSC report notes that because of the managerial environment in which government R&D managers must work, 'their positions increasingly acquire a distasteful image in the eyes of other employees, discouraging rather than encouraging scientists from developing interest and expertise in management functions'. This finding was supported in a 1982 salary survey of scientists in Canadian government departments conducted by the Ministry of State for Science and Technology. When asked if he would like to become a manager, a government scientist's reply was, 'hell no, I would rather drive a cab'.

In a survey of the impact of financial restraint on scientists employed in the Canadian Department of Environment, Farris (1980) found that 'the scientists reported that administrative policies and procedures have decreased their ability and motivation to perform well, their chiefs' abilities to manage effectively and spend adequate time with them, and reduced their opportunities for personal development'.

VIEWS OF CANADIAN GOVERNMENT R&D MANAGERS

Although the mandates of government laboratories and the ways in which their mandates are fulfilled differ, a number of common issues of concern were identified by interviewees and R&D management course participants. Some of the problems mentioned by respondents resulted directly from central agency actions whereas others were caused by poor management practices within a department or laboratory. In some cases the problems faced by the lower or middle level R&D managers were the result of a combination of central agency actions and short-sighted departmental decisions.

The most pressing problems facing government laboratories result from hiring freezes and cutbacks and restrictions in funding to science and technology based departments over the past few years. Despite reduced resources, most departments are expected to provide the same level of research and laboratory support services to the inspection and regulatory bodies they serve.

The financial restraints have also affected the way that government R&D managers have had to manage their operations. Many of the changes have had, and continue to have, counter-productive effects on the capability of the laboratories to conduct leading-edge research or solve problems in a timely manner, and on the R&D manager's ability to manage staff in the most effective manner.

LABORATORY PERFORMANCE LEVEL

The performance level of an R&D laboratory is critically dependent on the quality of the scientific and technical personnel, quality of the management and support services, a portfolio of challenging projects, the availability of state-of-the-art instrumentation, and adequate and stable funding.

Respondents indicated that many of these factors are not in place within government laboratories in either sufficient quality or quantity to ensure optimum laboratory performance. The following specific problems were identified.

Aging Scientific Population

A major concern voiced by all interviewees was the aging scientific population in federal government laboratories. The Neilsen Task Force on Program Review also found that aging staff with few new ideas were an impediment to productive research in some areas (Gov. of Canada, 1985). Two factors have contributed to this situation: restrictions on hiring new staff and the difficulties in firing or transferring incompetent or less productive staff.

A high level of creativity is maintained in an R&D laboratory by the influx of new ideas from new staff. In the Canadian government, a mandatory cutback on total departmental staff has been in effect for two years and it is therefore almost impossible to hire new scientists and engineers.

Although postdoctoral fellowships provide a means of obtaining new, temporary laboratory staff, funding and administrative restrictions limit a government laboratory's ability to make use of them. Some laboratories, however, have found creative ways of taking on postdoctoral fellows that avoid the onerous rules and regulations.

It is extremely difficult to fire staff in the public service for incompetence and therefore many managers avoided the additional workload required to initiate discharge procedures and retained staff who would otherwise be released. In addition, past hiring freezes have forced managers to retain less productive staff inherited from previous bad managers because the freezes prevented replacements from being hired. Thus openings for younger graduates are blocked.

Factors That Encourage Technological Obsolescence

Technological obsolescence exists when researchers use viewpoints, theories, concepts, or techniques that are less effective in solving problems than others currently available in their fields of specialization. Obsolete scientists or engineers who are not familiar with the best technical way of performing assignments take longer to solve technical problems and the solutions proposed are less effective than those of their more up-to-date colleagues. There is also a psychological cost to the individual which includes loss of self-respect, self-confidence, and status.

The factors that contribute to technological obsolescence can be grouped into two broad categories: those that are independent of the organizational context within which the scientist works; and those that are directly attributable to the organization's working environment. Among the factors in the first category are the rapid change in technology, lack of use of a particular technical skill, lack of personal motivation to keep up-to-date, and becoming too narrowly specialized.

Miller (1975) found that the following bureaucratic practices encourage technological obsolescence:

- restricted travel budgets which limit communications and opportunities to learn what others are doing
- restricted attendance at professional meetings, which inhibits technical interchange with one's peers
- limitations on reporting R&D results to external R&D community and on participation in professional societies
- elimination or reductions in participation in off-site educational updates and short courses
- limited or non-existent secretarial support for research report writing and editing
- restrictions on the posting and circulation of professional society meeting notices.

Other factors that contribute to technological obsolescence include:

- absence of a dual ladder reward system
- reductions in library/technical information services budget
- senior managers lack of appreciation of their role in encouraging or discouraging technological obsolescence through project assignment and support of course attendance
- low technical performance standards and poor use of performance appraisal interviews
- unreasonable project completion deadlines which do not allow a researcher to do a first class job.

In the surveys of Canadian R&D management course participants, the following factors in the government environment were mentioned as encouraging technological obsolescence:

- hiring restrictions resulting in an aging population, little turnover of personnel, and reluctance to get rid of deadwood
- a 'let them rot' attitude by lower level R&D managers towards scientists beginning to experience obsolescence (i.e., management ignores the problem)
- overloaded work demands, such as 'firefighting' and a feeling that time to browse in the library or attend courses should not be taken
- restrictive capital acquisition and budget policy which results in a reluctance to retire old equipment which was originally very expensive but is now out of date
- a lack of critical mass of people in an area
- restrictions on staff transfers/exchanges
- promotion for 'ordinary' performance, and a lack of rewards for above average performance
- an attitude of it's 'good enough for government work'
- no formal system of career planning

Training funds for Canadian government employees have been drastically cut which makes it difficult for scientists to attend work-related courses. This, in the long run, contributes to technological obsolescence. In one government laboratory, for example, the annual training budget is $20,000., or $75. per employee.

Conference travel is limited by overall funding reductions and by Treasury Board regulations that, if strictly interpreted, limit attendance at any one conference to one person per department. One R&D manager caustically noted that restrictions on, 'travel overseas and travel to conferences is a clear example of Treasury Board stupidity'. Conference attendance to exchange ideas and meet with peers is a critical tool for R&D managers to enhance creativity, to motivate technical personnel and to help prevent obsolescence. Some R&D managers exercise their creative talents in finding ways to overcome some of the travel restrictions imposed by Treasury Board.

Also contributing to technological obsolescence is the scientist or engineer's own attitude towards taking courses. McBride (1984) in his study of continuing education for scientists noted that government scientists in Canada have a negative attitude towards continuing education.

Lack of Critical Mass

Staff reductions have resulted in a loss of critical mass in some laboratories with a resultant dilution effect on research activities. Laboratories with mandates requiring them to conduct research in a number of different areas must continue ongoing research programmes with sometimes only one scientist working in an area. Laboratory support staff has also been reduced with the result that scientists must also do work formerly done by technicians.

The literature on the impact of size of research teams or laboratories on their effectiveness and performance appears to indicate that there is some advantage in having a research effort above some specific minimum size. Below the critical mass level, R&D activities appear to be ineffective, and solely aimed at solving immediate day-to-day technical problems (Clarke, 1985). The impact of size on the effectiveness of government operated laboratories has been noted by other authors (Wallmark et al., 1973; Noltingk, 1985; Toren, 1979). In a study of government operated industrial research institutes in Israel, Toren (1979) found that one of the contributing factors to their ineffectiveness in achieving their objectives was the subcritical size of many of the institutes.

Lack of Consultation in Goal Setting

One of the sub-roles of the government R&D manager is to ensure that the mandate of the laboratory is being carried out. This role is fulfilled by defining policies and guiding research.

A complaint voiced by one manager was the lack of consultation on research policy. Policies are often established at the administrative level, with little input from R&D managers, and in an environment of administrative constraints and systems that were designed for non-scientific areas. One interviewee stressed that to overcome this lack of communication, committees composed of administration and research personnel should be established to ensure that policy is set and directed by the best people. Input from research managers is essential. He stressed that in some laboratories there is a desperate need for competent planners. There is pressure in some areas for short-term targeted research and managers have to balance creativity and independence with the current goals and objectives of the department.

Programme Cutbacks and Project Selection Restrictions

New budget restrictions forced departments to re-evaluate all ongoing R&D projects with reference to the objectives, mandate and lower expenditure levels of the Department. As a result, some technical programmes were cut for political reasons, and some technical service programmes that might better be conducted in the private sector were eliminated. The across-the-board expenditure reductions imposed by Treasury Board have affected the remaining technical programmes.

In many laboratories, new projects or directions for research are proposed by the scientists. All proposals are subject to rigorous scrutiny and fewer projects are being accepted than in previous years.

Selection of projects is often made at senior levels of a department or at a political level, and the match between the interests or skills of the staff and the skills required by the project may not be optimum. The hiring freezes and the lengthy delays that often occur on staffing actions discourages the timely initiation of projects that require personnel with new technical skills. A contributing factor to the reduction in a government laboratory's ability to undertake state-of-the-art projects is that research managers may have to take technical staff transferred from terminated projects or programmes, even though they do not have the technical skills that are needed.

Factors That Discourage Creativity and Productivity

Creative thinking has been described as a special class of activity in which the product of the thinking has *both* novelty and value.

All senior government managers will claim that they encourage creativity and productivity among their scientists and engineers but their actions do not always match their words.

Numerous authors have identified the organizational factors which appear to enhance the probability of creative output from scientists and engineers. These factors are independent of whether the scientist works for government or industry. Among the factors presented in the R&D management literature are (Osbaldeston et al., 1978; Kaplan, 1960; Pelz and Andrews, 1966):

— being receptive to new ideas
— tolerating the oddball
— being part of a work team where coordination was not too high and where researchers had the ability to influence important decision makers
— freedom to follow up ideas
— absence of red tape and bureaucracy
— atmosphere of openness and trust
— time for reading, discussion and thought
— receiving recognition for one's creative contribution
— lack of uncertainty or insecurity
— lack of excessive pressure and work deadlines
— opportunities for self-development
— having well understood objectives
— encouragement to take risks
— participation in decision making which affects personal research work.

Among the factors which impede creativity are (Osbaldeston et al., 1978):

— workloads
— time pressures and deadlines
— management style
— organizational structure
— reward system

In the survey of Canadian government scientists and engineers attending the R&D management courses, the following factors were mentioned by the participants as inhibiting creativity in Canadian government laboratories:

— bureaucracy and red tape
— crisis situations and 'firefighting'/unreasonable deadlines
— lack of reward for creativity
— hiring restrictions resulting in burnt out colleagues, inadequate level of effort in a technical area, aging peers, and hiring delays
— poor communications between management and scientists, and between R&D groups and headquarters
— crowded laboratory space
— insufficient funds for travel and new equipment
— lack of clear promotion criteria
— lack of a clear organizational mandate which discourages long term research
— lack of risk taking by management/reluctance to try new ideas
— cumbersome purchasing policies
— having to devote time and energy to managing external research contracts.

Most of these factors are caused by poor R&D management at senior levels in the departmental hierarchy, a lack of appreciation of the level of financial support needed to conduct research and development, and a lack of will to spend the money needed to support first class research.

PURCHASING RESTRICTIONS

Budget restrictions have not affected equipment purchase in all departments to the same extent. Some laboratories have been able to maintain programmes for replacing capital equipment. However, the approval and purchasing procedures for capital equipment can result in delays of almost a year in actually receiving the equipment.

Some of the budget restrictions have resulted in higher costs to the government laboratories because of limitations on their purchasing activities. For example, during one spending freeze, some laboratories could only buy reagents, etc., for a month at a time and thus could not take advantage of lower cost bulk purchases. In addition, equipment tenders made before the freeze had to be resubmitted afterwards and sometimes came in higher. As one R&D manager noted, 'the freeze actually cost the taxpayer more in the end, although it was politically acceptable'.

TECHNOLOGY TRANSFER DIFFICULTIES

Although the government is trying to encourage the transfer of government technology to industry, some laboratories are experiencing difficulties. In some cases, problems result from budget cutbacks that have inhibited a department's ability to establish a dedicated unit concerned with transferring technology to the private sector. One laboratory manager stated that its technology transfer to industry was not formally managed and that it needed direction. Another said that higher priority problems were preventing the department from solving its transfer problems.

Another problem which has not yet been satisfactorily resolved is how to reward government scientists and engineers for their involvement in technology transfer activities. Few government departments have in place formal procedures for recognizing the contribution of technical personnel in successfully transferring technology. Present evaluation systems still emphasize the production of scientific or technical reports or publications.

Another major impediment that government R&D managers must overcome is the relative lack of Canadian companies with the technical capability to make use of government developed technology. One major laboratory is actively looking for companies to which it can transfer its technology, but finds that there are very few. There is a market in the United States but the laboratory is restricted to dealing with Canadian firms.

SELECTION AND TRAINING OF R&D MANAGERS

Selecting prospective R&D managers, and providing adequate training and guidance are two of the most critical managerial activities an organization can undertake. If done properly, an organization will avoid the many transition problems that can accompany the movement of a scientist or engineer into the first level of management (Badawy, 1983; Bayton and Chapman, 1973). If done improperly, the organization risks not only turning a good scientist or engineer into a mediocre manager or administrator but also reducing the morale and productivity of the research group they manage.

Inadequate Senior Research Administrators

Comments were received on the quality of senior people in administrative positions in some laboratories. One R&D manager maintained that some senior administrators are selected from scientists who have not been successful in the laboratory setting and who have been promoted 'upstairs'. He considers they have been selected from the wrong pool of people, have no management training, and do not maintain contact with the managers at the research level. This has resulted in a breakdown of communications between the administration and laboratory levels. Because effective R&D managers should be communications facilitators, scientists and engineers who have good communication skills and are capable of maintaining communications with laboratory staff should be selected for managerial positions.

An important element in the selection of R&D managers is to choose people who 'want to manage'. Selecting a person for an R&D management position simply because the alternative would be unemployment may result in the selection of managers who have no interest in being effective R&D managers, and have neither an interest in, nor the capability of acquiring or applying R&D management skills and knowledge.

Because of the poor quality of senior management in some science-based departments, some scientists in the laboratories do not respect people in administration. One interviewee maintained that research policy needs to be set by people who know science and who have the respect of the scientific community.

A senior administrative official of one government department admitted that their unofficial policy during this time of personnel cutbacks was to move redundant scientists and engineers into administrative positions to avoid the necessity of laying them off. This would contribute to the situation described above.

Problems Experienced by Newly Appointed R&D Managers

Numerous authors (Badawy, 1983; Bailey

and Jensen, 1965; Hower and Orth, 1963; and Bayton and Chapman, 1982) have identified the problems experienced by newly appointed R&D managers. These problems include:

- a feeling of isolation; not being part of the old group or the new managerial group
- a fear of failure as a manager
- a loss of time to conduct personal research
- having to accept the work of others/ delegating work
- poor interpersonal skills
- having to make decisions not based on hard facts
- having to interact with a variety of people.

Course participants identified the following as problems they experienced when first appointed to managerial positions:

- their responsibilities and authority were ill-defined by their own managers
- the authority assigned did not match responsibilities
- uncertainty about how much time to spend on technical work, and how much on managerial work, knowing that personal performance is still judged mainly on technical contribution
- learning to manage time effectively
- maintaining the motivation of subordinates
- gaining the confidence of subordinates
- setting goals
- learning the organization's administrative system
- coping with administrative responsibilities
- reducing level of personal technical work
- lack of management training
- lack of hard facts when making decisions or setting priorities
- introducing and implementing changes from previous practice.

Most of these problems can be overcome if proper selection procedures and criteria are used to identify prospective R&D managers, and guidance and mentoring is available from competent senior managers. In addition, adequate training should be provided to overcome some of the negative attitudes that scientists have towards management, and to equip them with the interpersonal and managerial skills required of an effective manager.

INADEQUATELY DESIGNED REWARD SYSTEM

In the federal government, managers have limited impact on salary increases for top performing staff as there is a quota system that restricts promotion opportunities. This tends to have a negative impact on morale and productivity as a person can be denied promotion simply because the quota for a particular salary category is full.

Travel restrictions that reduce conference attendance rob a researcher of the opportunity to receive peer recognition, which is a powerful motivator for many research staff.

As noted earlier, the present government reward and recognition system does not yet adequately recognize technology transfer activities by laboratory staff.

These difficulties reduce the R&D manager's ability to be a performance motivator.

SUMMARY AND CONCLUSIONS

The interviewees, the R&D course participants, and the few studies that have been conducted on R&D management in the Canadian federal government paint a rather gloomy picture of the environment in which highly trained scientists and engineers must work. It should be noted, however, that not all government laboratories suffer from all of these problems to the same degree and several are performing world class research despite administrative restrictions. There is also no doubt that many of the problems identified are not unique to the Canadian government and would be found in government laboratories in other countries.

At the root of many of the problems mentioned by the Canadian government scientists and engineers are inadequate funding of R&D in government laboratories, inadequately trained and ineffective R&D managers, and administrative rules and guidelines, promulgated by central agencies, that are inappropriate and counterproductive to encouraging creativity and productivity in an R&D laboratory.

These fundamental financial and managerial problems are resulting in:

- an aging scientific and technical staff
- technological obsolescence and inadequate career development programmes
- inadequate R&D budgets for the level of technical work expected
- less than adequate levels of technical effort in many scientific and engineering areas including technology transfer
- inadequate contact with peers in other organizations and countries, and inability to attend technical and managerial courses
- inability to provide suitable rewards for outstanding performance
- researchers being underemployed in technician roles, or misemployed in technical or administrative areas outside their competence or expertise
- inadequately trained R&D managers or administrators

These and other impediments to good management have a major negative impact on scientists and engineers who are trying to work to the best of their ability. In particular, these problems reduce the R&D manager's ability to fulfil the sub-roles of goal setter, performance motivator, and career coach.

Inadequate R&D managers compound these problems through their inability to provide a challenging, stimulating environment for their staff and through their inability to communicate with both senior management and subordinate technical staff. Their inadequate training as R&D managers means that they are not equipped to argue successfully against the inappropriate policies and procedures which hamper effective research and development in government laboratories.

Competent R&D managers do exist in the Canadian Public Service, but they receive little or no support from more senior levels in the government bureaucracy.

Because of the administrative and budgetary restrictions, some of which have been in place for at least ten years, it might be concluded that the Treasury Board of Canada is not interested in supporting first class research.

Recently, however, there has been a glimmer of hope that some of the problems identified in this paper may be addressed. In February, 1987, the Steering Committee on Science and Technology Management, co-sponsored by the Treasury Board of Canada and the Ministry of State for Science and Technology, held its first meeting to discuss what can be done about two areas of major concern: rejuvenating the scientific population in government laboratories; and improving the reward and recognition structure for research personnel.

To solve these problems, this new committee will have to be more knowledgeable about what constitutes a creative and productive environment for high quality R&D, and more committed to change than previous government science and technology management committees in order to stop and reverse the steady erosion of the science and technology capability of Canadian government laboratories.

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