Models and Policies

for the Commercialization of

Government Science and Technology

By

RockCliffe Research and Technology Inc.
Ottawa, Ontario

Prepared for
Industry, Science and Technology Canada

Contract No. 67GUS-8-2127
Dated March 1, 1989
and
Amendments
No. 1 Dated May 29, 1989
No. 2 Dated July 12, 1989

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- Its mission has undergone at least one very discernable change and this makes it a useful model on which to test a thesis about the relationship between a laboratory's mission and its technology transfer record.

The Communications Research Centre evolved out of the Defence Research Telecommunications Establishment (DRTE) that was set up as a research unit of DND in the early fifties. Its original mission was to solve communications problems for the Canadian Armed Forces. Originally, such solutions took the form of reports and scientific counselling on such problems as locating the source of radio transmissions and communicating during ionospheric instabilities in the far north. However, as time went on, the DRTE/CRC scientists found that the best way to solve such problems was to actually develop engineering prototypes of field systems. They became very adept at not only providing such solutions but at finding other problems inside the Armed Forces to which similar solutions could be applied. They were like highly qualified instrument salespeople, who after making one sale, would look around for similar problems so they could make several repeated sales. They became very sensitive to the needs of DND in technology-related products and services.

Many of these solutions led to products which had to be built by outside contractors. In the early days, such products took the form of ionospheric sounders, radar systems and specialized communications systems. Later on, they took the form of satellites, ground stations and mobile data communications protocols.

1. Scanning Electron Microsope

- Developed at DRTE in the early sixties to provide better reliability analysis for spacecraft hardware.
- A new company (SEMCO) was started with significant funding from DOC, DITC, and IRAP.
- NRC provided lab space and considerable technical assistance.

- Some of the founders were DRTE people.
- They floundered because of lack of business experience and external mentorship (there were no professional investors in the initiative).
- Ownership is now in hands of Vickers, having been bought from Bausch & Lomb, who bought it from Carl Zeiss Ltd.
- Products are now being sold to such markets as the semiconductor manufacturing industry.

Comments:

The government scientists and their managers did a good job of transferring the technology but not enough effort went into the development of a business plan and the implementation of a disciplined management process in the new company.

2. Fibre Optics Coupling Devices

- A unique type of fibre optic coupler was developed in the late seventies and DND provided funding to modify it for use on board ships.
- Canada Wire and Cable received a $157,000 contract in 1977 to further develop the product.
- Canstar, a division of Canada Wire and Cable, is now selling a family of devices based on the coupler.
- The volume of business is in the tens of millions of dollars per year - original inventors receiving reasonably high royalty payments.

Comments:

The contract to Canada Wire and Cable was the main technology transfer vehicle. Being a large corporation, it was able to provide the kind of management discipline and further technical development to productize the technology. The initial DND requirement helped define the product in the first place.

3. Telidon

- The original concept of transmitting pictures by using a superset of conventional data communication characters was originally conceived as part of the CRC space program in 1969.
- An interactive graphic program language was developed.
- Contract let to Norpak in 1975 for development of hardware and software for an interactive color TV display system.
- In 1978 DOC announced its version of the Canadian videotech system called Telidon and launched a $97M, four year program with Norpak equipment as the cornerstone.
- Norpak still sells products based on the technology but the major commercial windfalls originally predicted have not materialized.

Comments:

Telidon was a case of too much technology push and not enough market pull. While the CRC scientists did an excellent job of developing a protocol, there was never a clear definition as to what the products or services were or who needed them. The technology was obviously properly transferred, but there was a lack of market research to substantiate the business opportunity.

4. Mobile Data Radio Systems

- In 1972 a group of scientists at CRC undertook a project based on the recommendations of a federal computer communications task force which included the concept of government laboratories fostering selected areas of computer/communications developments.

- They began by assessing the demand for a mobile data terminal that would be used to access large central data bases from mobile platforms (e.g. police cars, firetrucks, real estate agents, etc.)
- In 1974, RCMP agreed to cooperate in a joint project to design and develop a modular radio system.
- Vancouver Police Force subsequently joined in the project.
- Original $1.2M product development contract won by MDA in Vancouver.
- In 1978, MDA, in consultation with Ventures West, a Vancouver based venture capital company, set up International Mobile Data Inc. (MDI) and transferred the technology and the personnel.
- Although the company went through many management changes it always had disciplined venture capital behind it and a strong board of directors.
- The company went public in 1986 and was bought out by Motorola in 1988 on the open market.
- Currently has sales in the $150M range.

Comments:

This is probably the best example of how technology should be transferred out of government laboratories. The scientists took the time to identify the market as well as develop the technology. When it became obvious that MDA was not equipped to develop the kinds of products that the technology would spawn, a new company was formed with new venture capital and new management behind it. A very competent technology broker in Vancouver (since deceased) arranged the transfer from MDA to MDI and the financing of MDI. The client interaction was also managed at a very high level in CRC.

Data Modems / Gandalf

- In 1970 CRC had a requirement for data sets to interconnect user terminals to a time shared computer at a 2400 baud rate.
- There was a temptation to develop the technology on site.

- A local entrepreneur offered to build a prototype at no cost to the Crown provided that a purchase order would follow.
- DRTE responded with a requisition for 20 units.
- The delivered product exceeded the specifications.
- The result is Gandalf Technologies Inc. which is a multinational corporation based in the Ottawa area.

Comments:

The technology transfer was well done because the DRTE scientists dialogued directly with the entrepreneur and both understood the technology, the product and the market. The entrepreneur had enough marketing and business knowhow to launch the new business venture. DRTE provided the most important ingredient of all which was a purchase order with a clear set of specifications. It meant that Gandalf became a product-oriented company as opposed to a special systems company. The main technology transfer vehicles were show-how and a contract.

Search and Rescue Satellite (SARSAT)

- Evolved out of an early demonstration system using a radio amateur satelite in early seventies.
- CRC and other government agencies helped in drawing up the specifications.
- Contracts were awarded to outside firms for special signalling studies which were essential to the development of the concept.
- Award of contract for SARSAT ground terminal to Canadian Astronautics Ltd. after competitive tender.
- SARSAT terminals are now sold by CAL to many countries around the world.

Comments:

The government laboratory provided the initial impetus by doing the basic research and system definition. The contracting-out policy encouraged CRC to do business with Canadian Astronautics Ltd. This project was also managed at a senior level in CRC.

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APPENDIX I

EXECUTIVE SUMMARY

Laboratories around the world are seen as potential engines of technology-based economic growth. Given the large proportion of Canada's scientific activity that is represented by federal government laboratories, it is important to find ways to maximize the commercialization of technology from government labs, without harming their ability to carry out their main missions.

Foreign and Canadian management models, each offering increased autonomy and accountability to government laboratories, have been examined and several appear to be very promising for particular Canadian facilities. In all cases, there is an incentive for both the laboratory and its employees to engage in successful commercialization activities. Flexibility, mobility, and freedom from excessive central control are the hallmarks of all successful models.

It is recommended that every laboratory have a clear statement of mission, including an economic development objective and a sub-objective to maximize the commercialization of technology. The key elements of commercialization are found to be the identification, evaluation, protection and marketing of technology. It is recommended that all managers be trained so as to have an understanding of these functions.

Canada has a serious deficiency in the capacity of its industry to be receptors for new technology from Canadian laboratories. Despite this, there is much that can be done to improve the commercialization of technology from government labs and it is believed that some of these improvements would, in turn lead to better receptors for

future technologies.

Of special interest are three foreign management models, namely the Fraunhofer model from Germany, the GOCO model from the United States and the Executive Agency model from the U.K. The Fraunhofer is especially applicable where contract research is important. It fixes the government's contribution according to the amount of outside revenue obtained by a given laboratory. The GOCO model as practised in the United States seems to have little applicability in Canada, although a more entrepreneurial version (Radian) may be more attractive for Canadian purposes. As to the Executive Agency model, it is attractive for those government business centres which serve several clients within the government, as well as some outside clients.

Among the Canadian models reviewed, the turning over of a laboratory to an industry cooperative, such as occurred with Forintek, is felt to have occasional applicability. The takeover of management by employees seems applicable in many situations, provided that there is already a strong business culture in the existing management. The Operating Agency model is a Canadian version of the U.K. Executive Agency and has the same applicability. Crown Corporations are seen as a form of outright privatization to be used when there is a compelling public policy need for the Crown to retain the shares in an otherwise profitable business.

A specific model, designed by the firm that has produced this report, is the Incentive-Based Lab (Radian), a variant of the United States GOCO model but with an incentive structure whereby new net revenues are divided between government, employees and the contractor-manager. It was seen to be applicable in the same situations as employee takeovers but with the advantage of bringing a business culture in from outside.

A survey of a selected sample of government research facilities showed that certain methodologies had been repeatedly used over the years and that certain factors turned out to be responsible for most of the successes which had been achieved. The methodologies included contracting out for the development of products, combined with purchase orders for such products (often using the Unsolicited Proposals Program). Licensing through CPDL is also important. Other techniques described included the dissemination of knowledge, transfers of individuals, provision of facilities, creation of research partnerships, and the general marketing of contract research capabilities.

The factors that tend to promote success, based on both the survey and the review of global experience, are found to be as follows: 1) A clear statement of mission, including a technology commercialization component, and a budget to develop or purchase expertise in technology commercialization activities (including technology transfer); 2) A well defined client (or clientele) with specific requirements and expectations; 3) Financial rewards for the facility, and for its management and scientists, whenever successful commercialization occurs; 4) Non-financial rewards, including prestige, career enhancement, travel and other benefits, for scientists who are successful in technology commercialization; 5) Contracting with Canadian firms to do product development work, followed by purchase orders for the product itself; 6) A source of funding for prototype development; 7) Management trained in and enthusiastic about technology commercialization; 8) Maximum flexibility for personnel to move back and forth between labs and private sector opportunities, on either a full or part-time basis.

To ensure that the above mentioned factors are maximized in each laboratory, it is necessary to categorize the labs and to apply the right policies and models in each case. Those labs that have clients apart from their own department are designated as Technology Centres and are separated along a continuum according to their potential profitability. The more profitable they are likely to be, the more autonomy they should enjoy and the more commercial they should become. Every Technology Centre should adopt one or another of the models described in this report.

For those labs which are not Technology Centres, it is recommended that they nonetheless work to improve their technology commercialization activities; it is particularly suggested that they adopt a Client-Supplier relationship vis-a-vis their department. This is seen as crucial in order to improve accountability and obtain value for money.

As far as the Technology Centres go, it is important that they be able to respend all new net revenues and have complete flexibility with regard to offering leaves of absence and rights of return to employees. It is also recommended that employees be allowed to receive much greater financial and non-financial benefits from any successes they achieve in the commercialization of technology.

For Technology Centres of low potential profitability, the models that should be considered include the Fraunhofer model, the Incentive-Based Lab, and the Employee Takeover. The same models apply for Centres of medium profitability but, in the case where an obvious client is a trade association, the Industry Cooperative might be used and, in the case where other parts of the federal government are important clients, the Operating Agency model could apply. For Technology Centres of high potential profitability, any of the above mentioned models could be used, possibly as a first step, but outright privatization makes the most sense, as long as provisions are made to separate off any functions that are too sensitive to be privatized. In occassional instances, Crown Corporation status might apply as a second best alternative.

A number of recommendations are made, including changes to the Public Service Employment Act, the Public Service Staff Relations Act, the Public Servants Inventions Act, and the Contracting-Out Policy. It is recommended that the Technology Centres Policy be strengthened, the Unsolicited Proposals Program be re-instated and CPDL be radically transformed. Since, in the absence of political will, bureaucratic territory is never yielded willingly, it should be no surprise that facilities have not devolved in any way despite a number of policies calling for this to happen. By combining financial incentives with assurances of security, it should be possible to apply one or another of the models discussed in this report to every Technology Centre in the federal government. This can be achieved by concerted action involving the Treasury Board and other Ministers, possibly under the IMAA framework.

N.B. **Recommendations are made in the course of the text and are flagged with an R in the right hand margins. These recommendations are then drawn together in the final chapter.**

INTRODUCTION

Every town, city, region and country in the advanced world is today formulating its strategy for success in a competitive global economy. In almost every instance, an important element of that strategy is a plan to capitalize on those institutions where people with special knowledge and skills have congregated, particularly to do research or improve technology. **Laboratories of all kinds are seen not only as places for research, service and teaching but also as "engines" of local technology-based economic growth.**

Thinking in this respect has been influenced largely by experience in the United States where several parts of the country have become "high technology centres" with success attributable to the presence and participation of skilled people in respected laboratories. It is with this in mind that Canadian Government laboratories will be examined in this report. The goal is to see what management models may be applicable in defined circumstances to orient a facility, not only to better perform its mission, but to actively spawn technology-based economic growth.

At the outset, it is important to note that **technology commercialization,** is the basis for economic growth and is a much broader concept than "technology transfer". Arranging for a piece of technology, developed in the lab, to be transferred to the private sector is certainly very important. Laboratories can act, however, as engines of growth in other ways as well, including such services as consulting, training, advice, testing, facilities rental, and secondment of personnel.

Furthermore, extremely important benefits can occur when laboratories contract out to a company the manufacture of specific pieces of equipment which they have designed and require for their own work; such contracts can be the basis for new product lines in the firm receiving the contract. Finally, in the United States, the most spectacular instances of laboratory-inspired growth have occurred where individuals have left (on a full time or part time basis) and have been involved in start-up businesses to exploit talents and technologies developed inside the lab.

What all of these transactions have in common is that they result eventually in commercial activity which is a consequence of new or improved products (goods or services), or new or improved processes.

There are several different ways in which commercial entities incorporate these products and processes into market place activities. For example, a large company may accept trained personnel or, if offered technology, may prefer it to be at an early stage of development. A small company, on the other hand, or even one created for the purpose, can only exploit a technology that is sufficiently developed to permit immediate marketing. How one actually proceeds, therefore, would be very different depending on the maturity of the technology, the presence or absence of large firms, and the local climate for entrepreneurism. The degree of development the lab can afford to apply to a given technology is a function of the mandate of the laboratory, its own needs and its resources.

As recognized by the Government in its IMAA policy, there are many operational groups whose efficiency and effectiveness would benefit from a greater measure of autonomous management. Many models are being considered, some of which have been successful in other countries. Depending on the degree of ministerial day-to-day control required, and depending upon whether the chief goal is economic savings or more effective performance (or both), different models are chosen for different circumstances.

Research establishments are not typical operational units, however. In addition to savings and effectiveness (or responsiveness), there is to be decided in each case the relative importance of the commercialization of technology. Even then, as this report stresses, management models need to be selected with a clear understanding of exactly of what type of commercialization constitutes the most reasonable goal.

What all models seem to have in common is greater freedom and autonomy for management, along with responsibility for results. Depending on circumstances, several models allow for management and/or the institution (and/or the employees) to be rewarded for success and held accountable for failure.

This report will consider several possible management structures but **mainly as they apply to research facilities**. Not all labs are alike. Some make their economic contributions indirectly through assisting a department to regulate wisely; some do strictly mission-oriented research in support of a departmental mandate; some are primarily aimed at advancing the technological base of certain industrial sectors; some advance a particular area of science; some offer testing or special facilities and many have more than one purpose. Our focus is mainly on those facilities **where commercialization of technology is considered a high priority.** Attention will also be given however, to other research facilities where commercialization may be relatively less important but could still be better encouraged.

In all countries surveyed, there is agreement that the most important commerical successes occur when a **key person,** involved in the development of the technology in the lab, is able and willing to spend significant amounts of time, after the technology has left the laboratory, working with the commercial entity that is doing the exploitation. In the United States, especially at Universities, such key persons are often rewarded with equity positions (shares) or generous royalties from the company.

Along these lines, a study a few years ago examined a large number of United States government lab inventions in order to see how they were followed up in the private sector. The results were generally discouraging but, of those that were highly successful, almost all of them involved the transfer of key persons (with an equity stake) along with the technology.

A very important feature, therefore, of any management scheme should be to permit and encourage individuals to leave the laboratory and join the commercial firm. The greatest encouragement comes from a scheme which is flexible enough to permit not only permanent leaves, but also temporary and/or part time arrangements which do not require a complete severing of links with the originating laboratory, and which permits retention of some of the security of the original job, as well as any financial benefits which come from successful technology exploitation. **While such flexible arrangements are easy in the private sector and are now customary at universities, governments have generally not yet worked out ways of embracing them.**

It is instructive to look at universities to see the changes that are occurring there. In the past, careers were not advanced by commercial success, expertise in commercialization was absent, incentives were trivial, etc., etc. Yet today universities are actively seeking industrial partners and are "spinning out" new companies at a remarkable rate.

Among the factors causing this change at universities have been: (1) a prolonged period of **financial deprivation,** (2) **flexible personnel arrangements,** so that employees can remain at the University even if and when they become wealthy shareholders in successful spin-off companies, (3) **recognition** by colleagues for success in bringing commercial revenue to the institution, and (4) the building of **expertise** in both industrial liaison work and in technology commercialization generally. Industries are starting to see universities as potential sources of important research information. Universities, for their part, are willing to cooperate in order to receive not only direct contributions but also major donations during fund raising campaigns.

With so many factors in play, there cannot possibly be a single "best" model for managing government laboratories to achieve commercial success. In analyzing different models, foreign and Canadian, existing and proposed, the aim will be to determine **the advantages and disadvantages of various management models under particular conditions.** Based on this analysis, government policies will be examined to determine the extent to which they tend to **inhibit** or

encourage the application of the right model for each circumstance. Finally, there will be some general guidelines and a few fundamental recommendations.

MISSIONS, MANAGEMENT AND COMMERCIALIZATION

To understand how a given management model can affect a particular laboratory, it is essential to begin by clearly defining the actual **mission** of the lab. While **managerial style** may ultimately determine success, such styles can be encouraged by a system that puts in place models appropriate to each lab's mission and to the type and amount of commercialization that should be expected in each case.

Each government research facility was created with a particular mission in mind. Those with the clearest missions knew from the very start the identity of their major clientèle and the specific needs which those clients expected the lab to meet. Those with the vaguest missions were generally created because of a belief that research in a particular area would, in unspecified ways, eventually be of commercial or social advantage to the country. Mixtures of the two types exist since drift has occurred in each case. Labs whose clientèle may be perfectly clear (e.g. a particular department) may have drifted into doing research of interest to its scientists rather than to develop particular deliverables for clients in the department. On the other hand, labs that were set up to do research in a general area may have gone out and developed a clientèle over the years and may be guided by the needs of such clients.

Apart from the National Research Council, Canadian government labs operate within Departments. When a Departmental lab is unclear about its mission, when it lacks clear deliverables and has a vague sense of who the client is and what the client wants, then it is an indication of one or more of the following:

1. The Department is itself unclear as to its own mandate in the Government;

2. The Department is unclear as to how the lab might produce deliverables relevant to the Department's mandate; or

3. The Department's needs are being met elsewhere and the lab survives for other reasons.

The need for departments to act as informed and demanding clients for its labs is very obvious. When labs are left without clear expectations and where deliverables are unspecified, the result will be poor management and low efficiency. Furthermore, **commercialization of technology is less likely to happen successfully in any laboratory where the mission and clientèle are vague.** A new management model might help force a clarification of the mandate, but it would be far better to decide the mandate and mission issues ahead of time.

Every lab should have a clear statement of mission. In each mission statement, there should be an economic development objective, including a sub-objective to maximize the commercialization of technology. R-9

Once there is a clear mission with channels and receptors for commercialization well identified, then the attitudes and abilities of management become crucial. **Management needs both the incentive and the knowhow in order to create a culture conducive to proper commercialization.** To appreciate the qualities of management necessary for successful technology commercialization, it is important first of all to understand the essential elements of the process itself.

Process of Technology Commercialization and the Role of Managers

For commercialization to be successful, it is obviously necessary to have, at one end of the chain, a source of good scientific research (preferably done with eventual application in mind), and at the other end, an enterprise capable of commercial utilization. In between, however, are three separate and distinct capabilities which are often overlooked in whole or in part. These **essential capabilities** are:

1. Technology Identification - To **identify exploitable technology and the products and services it will generate.** This includes being able to enter a dialogue with scientists on future technology directions, product usefulness and potential patentability.

2. Market Evaluation - To **evaluate the commercial potential** of a given technology, including criteria related to technical, market, financial and strategic considerations. This capability should extend to being able to produce a sketchy pro-forma business plan which would capture these various aspects, as well as an approximation of the expenses and revenues that would be anticipated in the commercial exploitation of the technology.

3. Marketing - To market the technology, either to an existing firm or to a new one created for the purpose.

These capabilities need not be exercised in any particular order. Market evaluation might be a good idea even before the research itself is undertaken. As a general rule, a reasonably guaranteed market should be required before patenting expenses are undertaken.

Whatever the order, the three capabilities together constitute a necessary "middleman" or "transfer agent" function. Such a function can be provided by an outside agency (e.g. CPDL), an outside firm (brokers), or by individuals or groups within the lab or department. No matter who provides it, however, **laboratory managers must have an understanding of these functions.** Without such understanding, a manager cannot give the leadership or establish the culture whereby commercialization becomes important within the competing value systems of a government laboratory.

There is clearly a need to select and train managers appropriately with regard to the commercialization of technology. Without such managers, successful commercialization will be a chance occurrence. The manager must be able to obtain a clear statement of mission for the lab and must keep such a statement relevant and up-to-date. While technology commercialization may be a minor part of the responsibility of certain labs, all managers should have a thorough understanding of the commercialization process and must be in no doubt about the identity of the laboratory's "clients". Naturally, the overriding consideration in selecting a manager is whether he or she understands the principles of management and is willing to pursue them diligently. **A training program, emphasizing the above-mentioned principles and focusing on the nature of technology commercialization, should be available to every laboratory manager.** R-15

THE CANADIAN SITUATION

Before considering management models, it is important to examine Canada's unique situation since it will certainly affect the operation of any models that are implemented.

One important feature of the Canadian environment regarding science and technology commercialization is the **relative lack of export-oriented, indigenous technology-intensive industries.** Canada has a long history of importing high value-added products and exporting bulk commodities based on our abundant natural resources. For most of this century, when import replacement in the high value-added sector has occurred in Canada, it has been by the creation of subsidiaries of foreign corporations. While many of these corporations perform some R&D, it is not usually for the purpose of developing entirely new products or totally new processes for export to global markets. Of course, this means that Canada has not only a significant shortfall in its industrial R&D capability, but also a **serious deficiency in the capacity of its industries to be receptors for new technology from Canadian laboratories.**

In places where technology-intensive industries do research and development to create new products, they are not only willing receptors for technology, they actually reach out to universities and other laboratories to create partnerships of various kinds. As a result of that, the commercialization of technology automatically gains increased importance in those laboratories. In relative terms, this "demand pull" is absent in Canada, as shown by the very low industrial R&D figures and by the huge trade deficit in advanced technology products, as well as by the domination of those sectors by foreign-owned firms. In the absence of such demand, **non-commercial activities tend to dominate in most**

Canadian laboratories.

There is an obvious need to upgrade the technology receptor capability of existing Canadian firms, including those that are foreign owned, and a special need to foster the creation of new firms to exploit individual innovations.

As noted above, the lack of Canadian presence in high technology exports is balanced by, and may be a result of, the heavy concentration of Canadian economic activity in the extraction and processing of raw materials for world markets. While technology is certainly important to resource-based industries, a small amount has in the past gone a long way. As a percentage of sales, the investment in research and development has been extremely small. The scientific base for mining, forestry, agriculture and the fishery, has been provided mostly by government laboratories. While government scientists have done excellent work in keeping Canadian science at the forefront of these areas, they cannot be expected to do the product and process research which rightly belongs in the R&D divisions of individual companies.

Partly because of the excellent work of government scientists over the years, and partly because of the natural endowment of the country, Canada's natural resource industries have been quite competitive without having to be technological supermen. Now that global competition is intensifying, however, there is a real need for more innovation in exactly those industries that have been the lowest spenders in the field of technology development. As these industries begin to change their habits and gear up to perform more R&D, their capacity to act as receptors for the products of government science will increase, and the role of government labs will need to change accordingly.

The natural outcome of the points discussed so far is that Canada has become a country with an enormous proportion of its R&D activities located within the government sector. With a lack of innovative industries and a dependence upon government science to manage its natural resources, the country has a smaller number of scientists per unit of the population than almost all other countries in the OECD, and, in comparison to those countries, has the **highest proportion of its scientific manpower in government jobs (See Table 1).** Since it is important in all countries today to capitalize on the scientific manpower that exists, **Canada must find ways to derive more commercial benefits directly and indirectly from government laboratories.**

TABLE 1

GOVERNMENT PERFORMED R&D

	AS % OF COUNTRY'S GDP	AS % OF COUNTRY'S TOTAL R&D
United States	0.34	11.7
Japan	0.28	10.0
Europe*	0.31	15.1
Canada	0.32	**23.7**

* Average of percentages in largest eight economies in Western Europe.

Source: OECD, Statistics Canada

There are several additional factors that are pertinent to the technology receptor capability of Canadian industry and which thereby affect the Canadian science and technology environment:

1. Whereas the need exists, as noted earlier, for new firms to be created to exploit some of the technology developed in government labs, the entrepreneurial climate to make this happen is largely absent. Canadian capitalists operate in a North American market, and the venture capital industry is much more highly developed in the United States. Investment opportunities in the US are often much more attractive than domestic ones for Canadian venture capital companies. Entrepreneurial management is lacking in Canada in comparison with the US and there is a lack of experience in the business of tailoring investment opportunities to the requirements of individual pools of capital.

   This is a major impediment in Canada. The fact is that leading edge technology is usually better exploited in new innovative firms than in large existing companies. In the larger firms, decisions take longer to make and there is often a "not invented here" resistance to ideas that are brought in from outside. An early stage entrepreneur will drive a given technology into many possible areas of application, whereas a large firm usually concentrates on the one area that it knows best.

2. Many of Canada's technology intensive firms are service oriented as opposed to product oriented. They provide consulting and contract research services which can be very important but they are unlikely to seize the major exploitation opportunities that would be available to a product oriented company.

   For government labs, the issue is very relevant. In accordance with government policy, they contract out a significant amount of research rather than add to their person-year complement. The firms which come into existence to do this research become good receptors for government technology, but they generally use it to deliver yet more research and consulting services back to the government, as opposed to developing products whose specifications they control. The government scientists and engineers who work with these firms tend not to have a product focus either, so there is a circular process in play. With strict government purchasing regulations, firms offering services to the government can charge only for overhead directly related to the service being provided. Product R&D, market development and other general overheads are, of course, not recognized. The result is that firms, once they get into the cycle of providing services to government, can rarely break that cycle by branching into product development.

Finally, service oriented firms tend to be financed by their founders with their own money as opposed to seeking professional venture capital. This is partly because venture capitalists are not especially interested in start-ups, especially those based on services. Without outside capital, however, it is very difficult to finance the development of products. So, again, the strictly service mode is retained.

3. There is a serious shortage of management talent in Canada for technology intensive firms. This may be related to the high level of foreign ownership; foreign-owned firms seldom provide a full range of management training since their senior managers are rarely exposed to the full spectrum of management responsibilities that their counterparts experience in parent companies. There is also the previously mentioned lack of professionally managed venture capital. This lack means that the entrepreneurs miss out on mentorship

and discipline that can be supplied by experienced venture investors and the outside Boards of Directors which such investors usually install. Overall, there has not been an entrepreneurial culture in Canada, especially in areas related to high value-added products and advanced technology.

To summarize this review of unique problems in Canada, commercializing the technology from government laboratories may be more important here than in other countries, but it is more difficult to accomplish, given **our diminished receptor capability and the obstacles to the creation of new receptors.**

The management model adopted in any particular laboratory will need to be designed with these receptor limitations in mind. There is no model that will solve Canada's receptor problem but several will help improve the situation. Models that help will be the ones that foster the creation of new firms (spin-outs), encourage government scientists to go out with the technology (thereby improving the receptivity of an existing firm), or attract foreign firms into worthwhile joint ventures or product mandates. This means the incentives and the budget must be present to induce and fund better packaging and marketing for the technology that is available. Models that cause venture capitalists and brokers to become involved with the management of the lab are more likely to cause the creation of successful, well managed spin-outs.

THREE IMPORTANT FOREIGN MANAGEMENT MODELS

In the right circumstances, a good management model will permit the right kind of manager to flourish, will encourage more precise mission statements to guide the work of scientists, and will assign an appropriate high priority to those forms of commercialization that best suit a given situation. In this respect, there is much to be learned from the experience of other countries and we shall review the models they have developed.

Fraunhofer-Gesellschaft (FhG) -- West Germany

The Fraunhofer is a very successful, well established **association of applied research institutes**, located throughout West Germany. While the exact nature of the Fraunhofer Society is based on its particular history and is peculiar to the West German situation, the basic underlying model is very clear and could well be applied in several different Canadian situations. In effect, it is a non-profit society which receives government funding according to a formula.

The organizational details are as follows. An "Annual Assembly of Members" elects a Senate which, in turn, elects an Executive Board for a four year term. The Executive board runs some thirty institutes while receiving advice from a scientific and technical advisory board, also an internal body. A Board of Trustees, which includes people from outside the organization, exists to supervise the way in which the Executive Board deals with the thirty institutes. This elaborate set-up is derived from the history of the organization and its particular role in West German society. It does not relate to the **key element** in the Fraunhofer arrangement, namely its focus on **applied research** and the

funding formula by which it operates.

Each institute in the FhG organization tends to specialize in a particular area of technology. In this sense, they are similar to individual NRC laboratories in Canada. The funding for each laboratory is decided by the Executive Board, but generally follows the same formula as is applied to the whole organization. Government supplies funding for capital, equipment and fundamental types of applied research. These grants come largely from the Federal Government but a small (increasing) proportion comes from the provinces (called Lander) as a group, along with a small contribution from the particular province where a given institute resides.

The most important and **pivotal** funding is obtained from **clients** as payment for contract research. Industries are invited to present their problems to specialists at the Institute who then make a proposal to do research on the basis of either fixed costs, cost plus, or cost plus with an upper limit. This contract research is the raison d'être for the FhG. Government is itself the client in many instances, with projects brought by various ministries, including Defence. These Government clients come by choice and are under no obligation to utilize the services of FhG. It should be noted that certain industrial users of FhG receive government subsidies amounting to approximately half the cost of the research done there; this applies when the company is small or medium sized ($100 million annual sales).

The crucial aspect of the funding is the Government policy whereby the grants for capital and for fundamental research are based on the other revenues of the FhG. **The more revenue from contracts or royalties the FhG earns in a given year, the more the Government will pay by way of grant.**

While the ratio has varied historically, it was recently fairly steady at a level of $1.00 in grants for every $2.00 of outside revenue. Outside revenue did include, however, money from Government clients and Government subsidies to industrial clients.

The Institutes operate as private corporations and have complete freedom from central government rules, regulations and labour practices. The institutes can spend the Government grant money as they see fit since the system of tying Government contributions to current revenues from the market place guarantees automatically that even the fundamental research will be done with an eye to future market requirements. So that government retains some control over its contributions, the ratio of contributions to outside revenue is altered from time to time.

This model seems suitable for Provincial Research Organizations and for those federal labs that could do **testing and contract research** for many customers, including government, while engaging in longer term applied research at the same time. It is not the best model for mission-oriented labs or for situations where new technology could best be used to start new enterprises.

Government Owned Contractor Operated (GOCO) -- USA

For several decades, the Department of Energy and the Department of Defense in the United-States have invited large private companies, as well as non-profit institutes and universities, to manage and staff some government research facilities, several of which are extremely large. The Manager is paid a management fee of 6 to 8% of the total laboratory expenditures.

N.B. A much more entrepreneurial version of the GOCO (Incentive-based Lab: Radian model) is described later in this paper.

In each U.S. case, the GOCO arrangement was instituted at the outset. No lab has been changed from a Civil Service operation to a GOCO. The management contracts are the subject of highly competitive bidding since they require little capital outlay and pay significant fees, especially in those labs which spend hundreds of millions of dollars annually. Even so, one or two very large corporations, such as General Electric, will not now bid for GOCOs because they can make more money on government research contracts performed in their own facilities. GOCO contracts come up for renewal every five years, but they have virtually never been terminated or given to a different contractor.

Until recently, contractors were discouraged from taking a role in the commercial exploitation of technology developed in these labs. The feeling was that government-sponsored research should be equally available to all possible users and exploiters. In the last few years, however, the contractors have been given active encouragement to commercialize the technology from the GOCO labs and several of them have set up special organizations to market such products and/or to finance new companies built around them.

Where GOCOs have been adopted in the United States, the main reason appears to be the desire for more **flexibility** regarding the hiring, firing, payment and promotion of employees. A second reason is the belief that a private company brings management styles and expertise different from the public service and can be held **accountable** for results, both technical and financial. The goals did **not** originally include making it easier to seek new clients, attract additional revenues, find new avenues of technology transfer or create spin-off firms.

The actual contracts for GOCO establishments are enormously complex documents, running into hundreds of pages. People spend millions just to enter the competition for such contracts. The contracts specify "tasks" which the laboratory will perform over the 5-year life of the arrangement and are revised every five years. There is also an annual revision of the details of each task, such revision done jointly by the department and the GOCO operator.

Once a contract is signed, the Government has a major financial burden in supervising and auditing the performance of the contractor, especially in large labs where the financial dealings can be very complex.

In at least once instance, a GOCO operator has been encouraged to set up its own laboratory right next to a GOCO facility and has utilized its own lab largely to do contract research for the same Department (Energy) of the Government. Employees move back and forth interchangeably, but the system of payment by the Government is different for the two laboratories.

In summary, the GOCO model as it has been practised in the United States appears to offer little advantage over traditional government lab arrangements, apart from slightly greater employee flexibility and a degree of contractor accountability. There is no reason to believe that costs are lower, but it might be that the specificity of the contract arrangement leads to greater precision in defining the deliverables from the laboratory. There have been few advantages so far with regard to enhancing the commercialization of technology, but the potential is there and steps are now being taken in this direction.

Executive Agency - UK

The United Kingdom has recently developed a model for certain government services, whereby the services can be **managed, staffed and priced** in ways that are more typical of the **private** sector. In Canadian terms, these organizations have most of the autonomy of a Crown Corporation and are accountable to Parliament through the appropriate Minister. One unusual feature, however, in comparison with a Canadian Crown Corporation, is the fact that the major client for the Agency's services is the **UK Government itself.**

The Executive Agency model has just come into being this year and has been applied at Her Majesty's Stationery Office (HMSO), a large organization doing hundreds of millions of dollars worth of business with every Ministry of the Government and with outside customers as well. Among other things, it serves as the Queen's Printer and as the protector of Crown Copyright. **Each Ministry is free to use the services of HMSO or to obtain similar services in the private sector.** This is a crucial element in the plan. The HMSO directors and executive officers are given complete latitude to run the company according to private sector models and can, most importantly, apply labour practices, wage scales and bonuses typical of the private sector even though the employees remain civil servants. **The Government insists on a certain level of profitability,** similar to that current in the private sector but pricing and performance are left to the Executive Agency to determine. **Since many of the customers are outside government and since the ones inside are not captive,** the Agency can meet its performance targets by **raising prices** but only if it performs in a manner that is **reasonably competitive.**

There is an item in the budget whereby the Government pays a subsidy for certain services in order that they be delivered more cheaply to the client. The most important such service is the printing of Hansard.

The key ideas behind the Executive Agency Model are those of administrative autonomy, escape from certain Civil Service employment restrictions, avoidance of hidden subsidies, and achievement of competitive efficiencies. For those reasons, the model makes excellent sense in situations where an institution is providing goods or services **primarily, but not only** to Government, to **more than one Department of Government,** and where **potential competitors** might exist outside of Government.

Plans are under way to apply the Executive Agency Model to certain research establishments in the UK. These may not all come to fruition but are being actively pursued. For example, the model has been suggested for the Building Research Establishment of the Department of the Environment, the Roads Research Laboratory of the Department of Transport, and various labs of both the Ministry of Defence and the Department of Trade and Industry. We have spoken with the main proponent of the idea, the Chief Scientific Advisor to the Prime Minister, and we have also interviewed the Chief of the Scientific Division of the Department of Trade and Industry, the Deputy Minister of Transport, and the Head of the Building Research Establishment. These interviews tend to confirm the essential characteristics of the Agency Model, as outlined above, and tend to underline the circumstances in which the Model should or should not be applied. It is worth considering this information in some detail.

From one viewpoint, research labs are service organizations similar to HMSO. Given greater autonomy and responsibility, freedom from Civil Service restrictions and so on, they should be able to transfer technology more actively and to offer their services and expertise at genuine market prices. It is thought that, once labs are given commercial targets and the freedom to pursue those, they will develop a greater degree of market relevance in their research programs and their technology transfer efforts.

The head of the Building Research Establishment (BRE) is looking forward to Agency status. His lab is a very large one with hundreds of employees serving "clients" in several ministries of the government. Some 15% of the clientele comes from the private sector for whom the BRE does various kinds of testing and some applied research. Potential private sector competitors to the BRE are in existence but the Director feels that the competition would strengthen efforts now under way to modernize his establishment. While he recognizes the possibility of losing certain government clients, he counts on existing personal and traditional relationships to hold on to these clients, provided the services are reasonably competitive. He especially looks forward to greater autonomy and responsibility in operating his large scientific establishment.

The reaction was very different at the Department of Transport where doubts were expressed about the Agency Model as it might apply to the Roads Research Laboratory (RRL) of the Department. The only real client of the RRL within the Government was the Department of Transport itself and there were thought to be virtually no prospects of developing clientele outside the Government. There seemed to be no real alternative laboratories to which the Department might turn for similar work. In a way, therefore, the Agency Model was something of a fiction (and a bit of a nuisance). Proponents of the Agency model see it as a means by which the Department and the RRL would **put their own relationship on**

a more business-like footing. In this respect, the existing problem perceived was much like that of any large corporation whose research department may tend to forget that the corporation is not only the major funder of the lab, but also its major client. Of course, corporations do not solve this problem by creating "agencies" out of their R&D departments; they usually find other more direct ways of achieving accountability.

At the Department of Trade and Industry, the view was mixed. It was agreed that the Agency Model worked best where there were many clients and several competitors and where Government was the main customer. It was conceded that, even in other circumstances, it might be mildly helpful in establishing a better "client" relationship with a Government Department. It did not seem terribly applicable, however, in a majority of DTI labs since they were there primarily to serve clients **other than Government** and had the task of developing and transferring technology for DTI. Therefore, the Agency Model seemed beside the point and they are now engaged in active consideration of various models for **outright or partial privatization** of their scientific establishments.

To summarize the Executive Agency Model, as it might apply to labs, it gives freedom and responsibility to the lab managers, but it obliges them to make a profit similar to existing commercial companies. They can price their goods, services and licenses high enough to make this profit even though various Government Departments are their main clients. Higher prices are "limited", however, by the fact that they might lose Government clients to other competitors and by the need to serve private sector clients in addition to Government. **Where there is neither real outside competition nor substantial outside clientele, the Agency Model would appear to do very little for a laboratory**

and would seem an unnecessary encumbrance. Although it might serve as a means of creating clearer expectations between a Department and its lab, and it could be the occasion for removing certain rigidities imposed by current Treasury Board practices (e.g. person-year restrictions, vote netting, etc.), there are other ways to create such flexibility.

The best candidates for the Executive Agency model would be labs that should serve several non-captive clients, inside and outside government; some NRC labs could fit this description.

SOME CANADIAN MODELS

Several models have been designed specifically for Canada and a few have been implemented, including some that border on privatization. Like the foreign models, they have strengths and weaknesses which make them suitable for individual circumstances.

A. Purchase of Operation

This is really privatization, except for the real estate. By means of this arrangement, a company **buys** the rights to **operate** a government laboratory as a commercial business. While government retains ownership, **the equipment and the space around it** are put at the disposal of the purchaser. The latter is under **no obligation to hire** any of the people who were government employees prior to the sale, but can do so if he wishes.

This model was implemented two years ago at the National Research Council's Electromagnetic Engineering Facilities. The purchase price for operational rights was relatively low ($250,000) and the purchaser was a respected, growing, medium sized company in the advanced technology field.

The crucial point regarding this model, however, is that the facility in question **had already been announced as scheduled for closure** because of NRC budget restrictions. The acceptability of this model to employees was a direct consequence of the fact that the alternative was a complete cessation of activities.

The applicability of this model is the same as for privatization (discussed later in this section).

B. Contracted Function

This is a truncated GOCO, applied only to people performing a certain function. An arrangement exists whereby virtually all the technicians and technologists in a given government facility are employees, not of the Government, but of a particular contractor. As with the U.S. GOCO model, this could be seen as a means of introducing the flexibility and incentives that might be difficult to arrange for the same employees were they to work directly for Government. As with the Radian model (described later), this could be an arrangement where employees could work part-time on matters of commercial interest and participate directly in the economic rewards.

As it happens, however, the only example that we examined makes little use of these potential flexibilities or benefits. The model is in place in the David Florida Laboratory in the Department of Communications (and elsewhere) and the employees appear to be treated in a way that was not too different from those working directly for Government. The contractor is paid a small commission for acting as the employer and performing certain managerial duties. The clearest benefit seems to be the evasion of limitations imposed by Treasury Board concerning person-years. In other words, this **model seems to have been used not so much to enhance commercialization, but rather to circumvent bureaucracy.** The main significance lies in the fact that it demonstrates the potential acceptability of other more complete models of contracted management.

C. Industry Cooperatives

Some government labs have been turned over to industry associations on a cost-shared basis of one sort or another. The prime examples are in the forest products and pulp and paper sectors.

While the best known is PAPRICAN, set up in 1925 and based originally on the forest products laboratory of the Federal Government, more pertinent to this report would be **Forintek,** created ten years ago by a somewhat controversial "privatization" plan. Forintek was a result of an agreement with industry whereby they would take on part of the financial support for both the Eastern and Western Forest Products Laboratories of the Department of Environment. It is worth examining this model in some detail since it is the most recent experience available that involves a major laboratory undertaking a drastic change in management model.

In creating Forintek, the Federal Government agreed to continue its support for the forest product labs but insisted that they be set up as a new organization outside government, with a separate Board of Directors and with a substantial financial contribution from industry members. As time has passed, this contribution from industry has come to be approximately 25% and a further 25% is being contributed by various provinces. The industrial contribution is collected from trade associations within the forest products sector rather than from individual companies. The Directors are drawn from both industry and government, with the industrial members clearly predominating.

The Federal contribution is understood to be purchasing work relating to codes and standards, and work related to the general upgrading of the Canadian wood products industry by means of technology transfer, training and education. The outside contributions are in support of general research, but there is some work done on a contractual basis for individual companies. Industrial advisors constitute committees which clearly influence the direction of the general research undertaken.

Although some observers regard the Forintek experiment as a failure, the results are certainly no worse than the pre-existing situation would have produced, and most people feel the model to have been, on balance, a modest success. The laboratories are believed to have contributed somewhat to the technological improvement of Canada's forest products industry and they have been able to attract money from provincial governments into an important area of research. On the negative side, studies of the forest products sector indicate that some industries have the **erroneous belief that participation in a cooperative organization like Forintek is a substitute for doing their own in-house R&D.** In fact, experience from the US and Japan shows that the only way for a firm to make proper use of cooperative R&D is to **increase** the R&D performed by the company itself. The passivity of attidude would appear to be a shortcoming of the industry and not of Forintek itself.

Strictly from the viewpoint of commercialization, however, Forintek does have some shortcomings. The incentive structure, both for individuals and for the lab itself, is really not much different from what it would be in a government laboratory. The scientists work more on self-generated problems than on work for clients. The "deliverables" to the Federal Government are vaguely specified in much the same way as they would be within the structure of Government. If, in the course of investigation, a major discovery with commercial potential is made, there is little personal incentive for individual scientists to spin out new companies or to elaborate the invention for specific customers. There is an active technology transfer operation whereby Forintek seeks companies as partners in introducing new technology or improved practice. This kind of operation is also present in many government laboratories, of course, but it is fair to say that Forintek can be more flexible in its business arrangements.

It seems a reasonable conclusion that, where an active industry association exists or can be created, and where such an association is an important client for a particular government laboratory, one obvious option is to allow the laboratory to operate as an industry cooperative i.e. a non-governmental organization which can receive contributions from both the trade association and the Federal Government.

While this model is a good way to restrain federal expenditures and to involve trade associations and the provinces, (in both a financial and an advisory capacity), it does not automatically promote a change in management culture. Trade associations are not a great deal better than government departments when it comes to being commercially oriented clients for research laboratories. The model could foster a change in receptor capacity if business would use cooperative research as a starting point for improving their own R&D capacity. Unfortunately such improvements are not yet common and too many firms still allow the cooperative R&D to substitute for their own. With greater individual commercial incentives, the research might orient itself toward perceptable market niches, thereby modifying or spinning out potential receptor firms.

D. Employee Takeover

This term has many meanings. It is understood that the Treasury Board is presently looking at a particular version of employee takeover to see if it would be applicable in Canada.

In the private sector, of course, the term "employee takeover" usually refers to leveraged buy-outs whereby existing management finds financial backers who will help them purchase their company from its owners. Applying that model directly to the public service would really make it a type of outright privatization. This is how "employee takeover" seems to be regarded in the Treasury Board document on Extramural Performance. In that sense, it would have the benefits and would suffer from all the difficulties associated with outright privatization, a topic considered in another section of this report.

Other types of employee takeover are possible, however. In the UK recently, some consultants proposed an arrangement that was somewhat different. The Government would continue to own the facility and its equipment, but would create an employee-based company to take over the operations and management. The model being developed in Canada at the moment may be somewhat along these lines.

The UK lab in question was one which had been offered for sale to the private sector. After many rejections, a deal was apparently struck, but it fell through and the employee takeover idea was raised as an alternative. The plan calls for existing (or new) management to operate the new company, with a Board of Directors consisting of prominent and/or interested citizens. It would operate on a non-profit basis in the sense that all profits would be either plowed back into the facility or divided up among the employees according to a formula. Considerable bonuses would be paid to all managers whose divisions met expectations and there would be provision for individuals to be handsomely rewarded in the event that their inventions led to substantial commercial income.

Government departments would continue to utilize the laboratories, but on a voluntary basis and at reasonable commercial rates. Actual government appropriations to the lab would cease, except for maintenance and equipment (which would continue for a limited time). Government could however, discuss a guaranteed minimum level of purchasing of research services for a specified period of time.

Losses were to be avoided but, if they occurred, they would be dealt with by borrowings from a government fund, with repayment out of future earnings. Reduction of staff complement and other economies were to be vigorously undertaken and usual Civil Service protections and rigidities were to be removed.

The model described here was under active consideration a few months ago and may have since been altered, rejected, or even implemented. In any event, it can serve for purposes of this discussion, as one example of employee take over.

Like the Executive Agency model described elsewhere, the employee takeover of management could apply when there are many prospective clients for the lab and where government can specify the deliverables it would expect as a major client. **It could be the first step toward complete privatization or Crown Corporation status.** The main drawback with this model is the difficulty in finding government labs where the current management is sufficiently entrepreneurial and sufficiently business-oriented to be able to bring about the major cultural shift required by this model. Employees in government laboratories are, with certain exceptions, not accustomed to operating in a business environment and the managers generally do not have the abilities to make such a radical change in corporate culture.

In any new enterprise, a Board of Directors can be extremely helpful in instilling a business mentality with proper management and reporting systems, and can act as mentors for the management. This crucial role of the Board is often overlooked. The employee takeover model might work much better with an experienced Board of Directors ready to put the time and energy into the task at hand. One concern with the UK model is the notion of Directors who do not have a financial stake in the enterprise and who are busy people with many other predominating interests. In Canada, it will be remembered how badly Canadair was managed, even with a blue ribbon Board of Directors including high level representation from the Federal Government. The Directors did not get personally involved in mentoring the company, but acted more like the Board of a large, well established bank or insurance company. Technology based firms, especially if a) taken over by managers with minimal business experience and b) attempting a major change in culture, need Directors who have the personal incentive and knowhow to act as involved mentors.

If employees **buy** the lab, then the management and monitoring will come from the people who provide the money. If there is no purchase, then outside help could be obtained to prepare the business plan and provide supervision on a consulting basis. Such consultants would be essential but would be more effective as a financially involved Board that could make changes in the management rather than as consultants dependent on management for their income. In this sense, the Incentive-Based Radian model (discussed later) is a variant of the employee takeover with a different managerial relationship.

E. Operating Agencies

Consideration is being given to applying the Executive Agency Model from the UK in a way that would adapt it to Canadian circumstances. A group at Treasury Board have named this the "Operating Agencies" model and have circulated an internal discussion paper on the subject.

The strengths and weaknesses of the Executive Agency Model, as applied to research organizations, and with a particular emphasis on commercialization of technology, are found equally in the Operating Agencies Model. There are very slight differences in Canada. For example if it were thought desirable to have a "separate employer" status, free of the provisions of the Public Service Employment Act and the Public Service Staff Relations Act, an Order in Council would be needed.

There are many non-research business units within the Government of Canada where creation of an Operating Agency would appear to make excellent sense. The applicability to research organizations is rather limited, however, with certain criteria to be met. The discussion of Executive Agency status applies equally to this Model in this regard.

F. Crown Corporations

Canada has a long tradition of dealing with entities that operate as businesses, but require, for reasons of public policy, a close relationship to the Government purse and a degree of ministerial accountability. The solution has been the Crown Corporation, namely a business enterprise in which the shares are 100% owned by the Government. There are several categories of Crown Corporations, each with different degrees of financial dependence and operational freedom.

It is certainly possible to have a research oriented enterprise which operates as a Crown Corporation. One example that comes close to this description is the Atomic Energy of Canada Limited Research Company, which, while not itself a crown corporation, constitutes a major portion of one, namely AECL itself. It performs research for AECL and in support of users of AECL products, as well as research for Energy, Mines and Resources on regulatory matters concerning the nuclear industry. Parts were split off to form separate business units at AECL when their markets became large and distinctive (e.g. Radiochemicals) and some of these are being privatized.

The National Research Council, officially a Departmental Corporation, is a type of Crown corporation but operates as something between a Department of Government and a Crown Corporation.

As a Departmental Corporation, the NRC has autonomy in determining its program and it has the status of a separate employer. Compared to AECL Research Co., what it lacks is **the ability to keep the revenues attracted from outside sources.** Because these revenues return to the Government each year, the NRC cannot make the investment required to eventually maximize such revenues. It is therefore difficult to establish a culture where a high priority is set on those activities which will lead to greater external revenues, both short and long term. In the circumstances, even members of the Council often see their roles as advisors on the scientific program rather than as directors of an entity that is supposed to provide a technology engine for Canada. Recent accommodations by the Treasury Board have permitted a slight increase in the NRC's capacity to retain earned revenues, but this falls far short of what is needed. Whether or not NRC should be a regular Crown Corporation is outside the scope of this report. It certainly needs the right to respend its net outside revenues.

Since Crown Corporations are regulated by the Financial Administration Act, they need an Order-in-Council whenever they take an equity position of less than 100% in another firm. This limits their ability to participate in spin-offs except via licences and consequently reduces the payback from successfuly technology. Unless the Act is changed, technology commercialization via creation of new firms will be impeded. One way around this impediment is to introduce an outside participant who can act as a "middleman" and can take a license where royalty payments relate to the value of the new company's shares.

The general problem with the Crown Corporation Model, of course, is the perennial question of whether a fully government-owned entity can be a truly effective commercial player, given the political and public policy considerations that are inevitably brought to bear. If it is worth making it into a business, why load it down with political baggage? Public policy can be brought to bear via regulations and via purchases made by government (e.g. certain types of research or products). If a research facility also determines certain standards for the country and/or does considerable research and testing for regulatory tribunals of the Government, there arises the possibility of conflict between these functions and the strictly commercial ones. In that case, the sensitive functions can be held back as part of government and the remainder privatized in some manner.

There is also the matter of longer term applied (or even basic) research which, by tradition, has been the responsibility of certain government laboratories, including the NRC. Even in a strictly commercial culture, it is certainly possible to continue "selling" such basic research services to the Government in the same way that appropriations are now sought each year. People doing this type of research fear they might then feel somewhat out of place (a reversal of the present cultural attitudes in some instances) but it is not a serious drawback.

In summary, Crown corporation status is becoming less popular all the time and carries no advantage over other models. If there is no other way to arrange the re-spending of outside revenues, then full Crown Corporation status could be an improvement for an organization like NRC.

G. Outright Privatization

While Crown Corporation status is a form of privatization, the shares remain held by the Crown and there is a considerable degree of accountability to Parliament. The Canadian Government, along with governments around the world, has expressed the view that commercial businesses often operate better when they focus on their efficiency and profitability rather than on the perceived political wishes of the Government of the day. Where public policy considerations are of great importance, they can be brought to bear by a strict regulatory environment in some instances. The obvious example of Air Canada and the AECL Radio-chemcial Company indicate that privatization can be a feasible and popular alternative to Crown Corporations in the right circumstances.

The criteria for choosing complete privatization are fairly simple. The potential business must be profitable and there needs to be no compelling reason for it to stay in the government.

The question is whether this can or should be done where research facilities are concerned. There is nothing complicated about this model in principle since it involves a willing seller, defining certain assets and selling them at an agreed price to a willing buyer. That is simple enough where the assets are easily evaluated and where the organization being sold is already a "business". In those circumstances, a simple change in ownership is unlikely to create immediate drastic consequences. **A research facility, on the other hand, is rarely operated as a business within Government and is almost never going to be an attractive object for an outright purchase.**

The Communications Research Centre was the subject of study over many years in order to see whether a communications firm (or group of firms) would be interested in buying it. No such interest could be created. More recently, there was interest indicated by Lavalin Inc. in what was reported as a possible purchase of the Surveys and Mapping Branch of Energy, Mines and Resources. The idea was to use the expertise there to sell services to the private sector and to other parts of the world. A similar rationale could apply to many other testing labs in various ministries, provided there are state-of-the-art facilities and world class expertise in a given lab, its services might well be in demand in other countries. The difficulty lies in the fact that even such service-oriented organizations would have to be drastically trimmed and refocussed in order to be commercially successful. Employee and union resistance is therefore extremely high and there may also be concern in the scientific community that valuable expertise is being lost in such trimming.

Privatization with the promise of a government contract for a given period of time would obviously be more acceptable to prospective purchasers and somewhat less threatening to employees. Purchasers would still be concerned about what happens after the contract expires and employees would still fear that the new owners would seek to maximize profits by cutting back on staff. There also arises the danger that the only purchasers interested would be certain existing clients of the laboratory. If one client purchased it, it might become problematic for other competitors to obtain services from that lab. In the UK, there is a policy against selling laboratories to individual clients in such circumstances.

The way that most government laboratories are functioning in Canada makes it difficult to tease out the potentially attractive commercial sections from the rest of the laboratory organization. To the extent that such sections can be separated from the rest of the lab, they might well attract buyers, but such situations would be rare.

It should be noted that **other models such as employee takeover, agency status or incentive based lab could be seen as a step toward eventual privatization at a later date.**

H. Incentive Based Lab (Entrepreneurial GOCO-Radian Model)

A variant of the United States' GOCO Model described earlier, the incentive-based model has been proposed recently for a possible trial in Canada. This will not be described in much detail in this Report, however, for two reasons:

1) It has never been implemented, and

2) The Model was designed and is proposed for implementation by Radian Research Management, a division of the company that has been commissioned to write this report. Objectivity would therefore be questionable.

Put briefly, the idea is for a lab to operate as a government-owned but contractor-operated facility with the contractor paid a small fee. Unlike the situation in the US, however, **there would be an incentive for the facility and its contractor to achieve commercial success and to find new clients and spin-off opportunities**. The incentive would take the form of permitting additional net revenues to be retained by the facility and divided, according to formula, among the employees, the contractor and the government (with the Government portion preferably returned to the facility itself). To enable maximum flexibility in commercial arrangements, the employees give up the status of public servants and work for the contractor, but the contract itself guarantees that salaries, pensions, benefits, union affiliations, etc. can remain as they would be in a public service situation. For such guarantees to have meaning, there would need to be approval by Treasury Board regarding portability of pensions and a limited "right of return" to the Public Service should the contract fail in some way.

In effect, the Government would pay what it is now paying to operate the lab, but instead of appropriations, it would enter a contractual arrangement and would receive specified deliverables roughly equivalent to what the lab is now providing. In this respect, the arrangement is similar to the U.S. GOCO.

The incentive basis of this model, however, provides for the employees to be free to make part-time arrangements, hold shares in spin-off companies, and share in the commerical benefits attained by the lab. With such incentives, it is assumed that commercial success would be more likely and that decisions such as patenting or further product development would be made in a way that was more likely to pay off commercially. An additional benefit is thought to be the managerial help which the contractor can give to the existing laboratory management. The commercial orientation of the contractor and the access to venture capital which such a contractor should bring could enhance the likelihood of a business culture being introduced successfully into a government laboratory.

On the negative side, as a result of a change in employment status, employees and unions will feel threatened with a loss of security no matter what guarantees are provided in the contract. Moreover, a change in culture will be upsetting for many people and will be resisted by some. Approval for pensions and for right of return may raise other thorny issues. **Departmental managers do not like to see large segments of their "turf" given over to contracted management of any kind;** it is noteworthy that the US GOCOs were always started de novo and not implemented in existing Public Service institutions.

There are also administrative difficulties in implementation. Many existing expenditures are hidden in other budgets, many existing clients enjoy relationships that are decidedly not commercial, some of what goes on in government laboratories should not be commercial under any circumstances, and "specified deliverables" are sometimes hard to pin down.

On balance, the model seems to deserve consideration for those laboratories whose main missions or mandates relate to the enhancement of industrial capacity in a relatively direct way and/or those laboratories where state-of-the-art services are provided and could, as a commercial entity, attract new customers, domestic or foreign. In other words, it is designed for labs where outright privatization makes sense commercially, but is impossible for other reasons, and for situations where employee takeover and agency status would apply but where the additional business orientation of an outside contractor would be desirable.

CURRENT TECHNOLOGY COMMERCIALIZATION PRACTICES IN CANADIAN GOVERNMENT LABORATORIES

A Survey of a Selected Sample of Government Research Facilities

In preparing this Report, it was felt necessary to do some research into current practices pertinent to the commercialization of technology. The sampling of facilities was entirely subjective and constituted an attempt to derive information from various departments in different parts of the country. The sample is neither scientific nor complete, so there may well be other methods of commercialization that have escaped attention. Still, the variety of methods described is interesting and there were several common arrangements that existed almost everywhere.

In each case, a letter was sent to the person believed to be in charge of technology transfer in a given laboratory. This letter explained the nature of the project and gave notice that, if acceptable to the lab, a person would be calling in order to seek information on the subject of technology commercialization. One interesting observation was the willingness of the laboratories to cooperate and their intense interest in the subject of commercialization. In only one case (CANMET at EMR) was there any concern expressed or resistance offered, and even in the one instance, the information was eventually given.

Telephone interviews were done and were generally brief, consisting of two basic questions. The person was asked to describe a successful instance of technology commercialization from that research institution and also an example where commercialization failed to occur. In each case the respondent was asked to identify any government policies that contributed to the success or failure of the commercialization process. Some additional information was usually volunteered concerning the research mission of the establishment and the approaches being taken to improve commercial performance.

This section consists of a brief review of examples of success and failure, institution by institution. More detailed information was received in confidence and will be made available to qualified government officials.

1. Institute of Ocean Sciences, Sydney, British Columbia

To illustrate a successful commercial initiative, there is an instance of software development regarding hydrographic data logging. At a given point, a private contractor was brought in to work with an in-house software expert and PILP was used to help transfer the software to the contractor's firm. DFO purchased five systems from the firm and, now that the Federal Government has agreed to standardize such data acquisition systems, a successor company to the original firm will sell $1.5 million worth of systems to DFO and will attempt to enter international markets. The Government policies which were **found useful were contracting out for systems development, combined with a willingness on the part of Government to procure the systems at an early stage.**

The IOS has **found the Unsolicited Proposal mechanism (UP), recently cancelled, to be the single most useful tool for contracting out.** Proposals were jointly developed by private sector applicants with the cooperation of IOS staff.

On the negative side, there was an example of a positioning system developed by a small company acting as contractor to DFO. Commercialization was not successful because CPDL allegedly insited on an up-front fee in addition to royalties, something the small company could not afford. The other negative feature in IOS efforts to commercialize technology has been the **fragility of the small companies who act as receptors.** There is a lack of management, marketing and business planning skills and there is a perceived need for "brokers" or other technology commercialization experts to offer mentoring and otherwise help these companies develop.

2. Bedford Institute of Oceanography, Darmouth, Nova Scotia

A high profile BIO success seems to be the deep ocean logging platform with hydrographic instrumentation and navigation (DOLPHIN). Begun by a contractor via an unsolicited proposal to DSS (with the Canadian Hydrographic Service), engineering prototypes of the system were developed under the DSS Source Development Fund. The BIO supplied expertise and ship time. The system and the vehicle which incorporates it are being sold to the US Navy and there are other interested potential purchasers. **The importance of the Unsolicited Proposal Program in this instance was in helping fund the development of component prototypes.**

An unsuccessful instance relates to seabed mapping technology. The contractor produced a product that was too sophisticated for the market and so costly to develop that the company went bankrupt. BIO staff regret the demise of the Unsolicited Proposal Program and express the desire for a **proper budget for technology transfer.**

3. Agriculture Canada Research Station, Fredericton, New Brunswick

A major success here has been, by means of **demonstration programs and other educational techniques**, the introduction of a new potato variety which has become widely accepted.

On the unsuccessful side, there have been difficulties in transferring hardware. For example, this station developed a roller to protect potatoes during processing, but claims that equipment manufacturers were unable or unwilling to modify their existing products. Helpful policies include the smooth functioning interface with provincial government extension personnel. Impediments, particularly where hardware is concerned, are said to be a lack of budget for marketing studies or prototype developments. Further obstacles are the **lack of recognition for successful technology transfer** and the tendency to lose the promotional abilities of the innovator when the technology is handed over to the provinces for diffusion.

4. Agriculture Canada Research Station, Lethbridge, Alberta

In one success, the Lethbridge Station took a device which permitted shallower plowing and better wind erosion control, improved on it and helped publicize it. As demand consequently developed, the inventor of the plow, a farmer, started a manufacturing company which was very successful.

Other successes deal with the introduction of new crop varieties and the development of minimum tillage techniques which are then diffused by a considerable amount of **extension work with farmers.** There is promising work going on at the moment between the Lethbridge Station and a number of chemical and biotechnology companies. Lethbridge offers **advice and facilities** and they are trying to work out a means of sharing royalties.

As an example of an unsuccessful transfer, there was a particular strain of wheat which had many good features but, once in the market place, turned out to have a tendency to sprout easily and was therefore rejected.

At this station, much of the effort is on researching new approaches to farming so as to improve, among other things, soil conservation. This kind of applied research is commercialized by means of education rather than by creating firms or finding industrial partners.

5. Ministry of Forestry

In one reasonably successful case, forestry scientists developed a particular bacterium to control spruce budworm without having to spray pesticides. This was transferred largely by **publishing results,** thus stimulating companies to commercialize the technique.

In another case, remote sensing technology was developed by the Canadian Forestry Service and **licensed to a Canadian company**, leading to international sales.

In an unsuccessful situation, a timber slicer was developed and licensed to a company, but the product **failed in the market place, having been released before**

the final steps of development had taken place. Among negative factors are the impression that **CPDL places more emphasis on legal rather than marketing functions** and the observation that the current **royalty system left little or no incentive for the department and the laboratories.**

6. **Animal Diseases Research Institute, Nepean, Ontario**

In a successful instance of technology transfer, dianostic and/or preventative agents were developed by the Institute and were commercialized by Institut Armand Frappier. Negative examples were not given but, while CPDL was described as slow but effective, it was believed that **a greater percentage of royalties should accrue to government scientists and to the lab.**

7. **National Water Research Institute, Burlington, Ontario**

A successful situation exists at the Hydraulics Laboratory within the NWRI inasmuch as private companies are making extensive **use of the facilities on a rental basis.** Another instance of success was the development of an analytical system which was picked up free of charge by a firm in Toronto, the results having been **published in the literature.**

On the negative side, while no specific examples were given, the Institute feels the **lack of budget and career incentives** to encourage scientists to work with industry, and the **need to source private sector expertise in market analysis and technology transfer.**

8. **Defence Research Establishment: Atlantic, Dartmouth, Nova Scotia**

One success was the development of electronic micro-sonobuoys to detect submarines. By **contracting out the R&D** to two Canadian manufacturers, prototypes have been developed and the companies can now compete internationally.

In another reasonably successful situation, software regarding ship structure and design was developed in-house and then licenced to a Canadian company for marketing. DREA believes that contracting out, the development of long term relationships with companies and the **introduction of industries at an early stage** of the research are all helpful policies. Especially important is the fact that Defence laboratories have the **Department of National Defence as a well defined client** so that end uses and products are always kept in mind during the research.

In an unsuccessful instance, a design capability regarding propellors was offered to industry, but no market was found since the technology was **too sophisticated for the realities of the market place.** It was suggested that DND **procurement contracts should go only to firms prepared to engage in considerable R&D.**

9. **Defence Research Establishment: Ottawa, Shirley's Bay, Ontario**

A successful example of commercialization involved a reliable and accurate navigation system which was developed in the lab, but taken to the prototype stage by a Canadian company **under contract** to DND. The contractor is now licensed to produce a system and is **supplying product** to the Department.

Telidon was cited as an unsuccessful example. It was really a DOC technology, but DREO is co-located with the Communications Research Centre at Shirley's Bay and it was mentioned by the DREO person as an example that stands out in people's minds at the site. In the Telidon situation, a product was developed at great expense **without a sufficient grasp of what the market required.**

10. **Defense Research Establishment: Pacific, Victoria, British Columbia**

A system developed for detecting magnetic anomalies was licensed to CAE Electronics Ltd. The latter firm combined it with some of their own technology and produced a system which has been sold widely. DREP scientists worked closely with CAE in further development and in demonstrations. As a consequence, it is believed that **early involvement in the lab's research, by a company which will eventually commercialize the technology**, is extremely important.

In an unsuccessful case, a method for drilling holes into ice was developed but there was **no commercial interest.**

11. **Mineral Technology Branch, CANMET, Ottawa**

In recent years, this lab has been stepping up its efforts at technology transfer. They suggest that one successful case involved incremental improvements in open pit mine design. These have been diffused by offering **advice and education.** Similarly, site-specific advice on upgrading foundry operations has been given with good results.

As for product development, CANMET developed a new ceramic filter for underground diesels. This technology was acquired by Corning Glass and a total unit was assembled by a Canadian company.

Where success has occurred, credit is given to the close relationship with industry and the advisory committee system which has been established.

As for an unsuccessful attempt, there was a lack of industry interest in an instrument CANMET developed for measuring cyanide content in gold solutions. With the recovery of the industry, however, recent interest has been shown and success may yet occur. Obstacles to success generally involved budgetary controls on equipment and travel, and the **need for better rewards to the laboratory and the scientist** when innovations are successfully commercialized.

12. The Communications Research Centre, Shirley's Bay, Ontario

Given a number of studies on this Centre, it was the subject of special attention in our survey. The results are described in Appendix I.

One particular success was a fiber optic coupling device developed in the lab and then **further developed by Canada Wire and Cable under a government contract.** This has become a major product for the company. Another success was the mobile data radio system designed in the lab with the cooperation of the RCMP and then taken over by a Vancouver company under a **product development contract.** The technology and personnel were subsequently transferred to another company which has been extremely successful.

Other successes include the search and rescue satellite and data modems. Telidon is given as an unsuccessful example. All of these are described in Appendix II.

13. Institute for Research in Construction (IRC), National Research Council, Ottawa

One type of success is said to be the gradual improvement in building standards related to energy conservation. Research at the Institute, followed by education and encouragement of industry, led to the use of better materials and practices, backed up by standards derived from IRC Research.

Another example is a light metering system, consisting of software combined with a video camera and display. In this instance, a key researcher left the IRC and is said to have formed a company to commercialize this system.

Lately, more IRC research is oriented to meet the needs of specific clients who have provided research funds in fields such as salt corrosion and the testing of flamability of materials. Currently over 50% of IRC work is carried out for a client.

One the negative side, the problems are said to be receptor related, given that the construction industry is large, unsophisticated, and often capable of succeeding without technological innovation. Greater flexibility in funding and employment is also suggested in order to provide both budget and incentive for more technology transfer and to make it easier for scientists to launch new companies.

14. Division of Physics, National Research Council, Ottawa

An instance of successful technology commercialization is claimed to be the development of EXCIMER laser technology which was taken to the prototype stage by the lab and was then licensed through CPDL to Lumonics.

Another instance, was the development of a mass spectrometer developed by a Toronto company with the help of the Division's gas analysis capability and with IRAP funding. Another example is that of the Enerstat system, a digital temperature control device, where two NRC physicists left the lab and were successful in commercialization of the technology.

Where success occurs, it is said to be geared to working closely with the technical personnel of an interested company. The division is now trying to do contract research for clients and to organize a shared cost program with industry for precompetitive research in opto-electronics.

On the negative side, there is a case of thin film flat display technology which has been held up because the receptor company has not found funding. On the policy side, rigidity regarding person years and budgets interfere with the ability to do contract research. It is felt the Public Servants Invention Act, whereby the Crown keeps the intellectual property from research it has funded, may impede the ability to bring together a major industry pre-competitive consortium.

CURRENT METHODOLOGIES FOR TECHNOLOGY COMMERCIALIZATION BY GOVERNMENT LABORATORIES

From the survey and from other conversations with laboratory managers and government scientists, it is clear that many different methodologies are in use, singly or in combination. Certain strengths and weaknesses appear repeatedly and fundamental needs can be identified. This section will review the current practices and will address broadly the lessons that have been learned.

The Methodologies

1.a Contracting Out
1.b Purchase Orders

These two **separate** techniques are frequently cited in the survey. When **combined** they are said to be responsible for the most outstanding examples of successful commercialization of government technology.

The contracting out is a certain type. The laboratory will arrange for industrial firms to be paid for performing product-oriented **developmental research**, based on in-house work which has been taken to a certain point by government scientists. The government lab has to think through its research program over a longer term, orienting it to a clearly defined commercial opportunity. The firm receiving such a contract gains by exposure to expertise and facilities that they would not likely acquire on their own. The firm becomes intimately involved with the final development of the technology and is then in a much better position to market it effectively and to make ongoing improvements. Such advantages would be absent, for instance, in a straight licensing arrangement with a firm that was unfamiliar with these steps in the technological development.

The labs report that contracting out works particularly well when target firms are brought into the R&D process as early as possible and where long term relationships with individual scientists can be cemented.

In many cases of contracting out, the firm is able to share the cost of the final stages of R&D and the development of prototypes. With many small firms, however, such cost sharing is difficult. Yet these are precisely the firms that can be most innovative and flexible in exploiting the new technology. One of the most successful programs for solving this problem has been the **Unsolicited Proposals** Program of the Department of Supply and Services. By means of this program, **prototypes** have frequently been funded and have proven the essential step in successful technology commercialization. Several labs have expressed dismay at the recent demise of the Unsolicited Proposals Program.

Purchase Orders have been crucially important in several instances. Provided they are large enough, they too can fund the development of prototypes. They can also serve to attract venture capital to a new firm. In most instances, a laboratory might identify a piece of research equipment or a service for its own in-house needs or for its major client (such as Defense or Communications). This equipment is such that it can only be developed from technology a laboratory has already designed or produced. By defining the product and helping identify potential markets, government scientists can exercise significant leverage, helping firms enter important market niches. After all, such product needs are rarely specific to one place, but are generally common to other similar laboratories and clients in Canada and abroad. Several success stories have resulted from these purchase orders. The **Source Development Fund** at DSS, canceled a few years ago, was very helpful in getting Canadian technology firms started by means of strategic procurement. Procurement is universally regarded as important to small technology companies, although alleged recent bureaucratic over-zealousness at DSS has been a cause of some concern.

By combining contracting out and purchase orders, firms that have their own R&D capacity can work closely with government scientists to "productize" the Government's technology, develop prototypes and launch major product lines. This combination needs to be encouraged wherever possible, but it has the following requirements:

a) Sufficient budget;
b) Research with a product orientation;
c) Scientists willing to work with industrial partners;
d) Receptor firms that exist or can be brought into being for the purpose.

These requirements are obviously easier to meet when the general management system of the laboratories provides rewards for behavior appropriate to the circumstances.

2. Licensing

In cases where the technology is patented or where the knowhow is clearly definable, laboratories can grant licenses to industrial firms who will use the process or market the product, as the case may be. There are many instances, both successful and unsuccessful, where this rather standard form of technology transfer has occurred.

As indicated in the previous section, licenses work very well when they are given to the same firm that has already been involved with the lab in developing the particular technology. There are other observations that are repeatedly made concerning the licensing route and these deserve consideration. In the first place, it is generally accepted that small entrepreneurial companies are more innovative and flexible in finding niches for the technology. Larger firms tend to "sit on" the technology either for defensive reasons (i.e. to prevent the competition from getting it) or simply because the decision cycle takes so much longer inside a large organization. In any event, the large company is likely to use the technology in a way that fits its traditional pattern rather than seek novel applications for it.

Balancing that tendency, however, is the fact that small firms are frequently too fragile and cash poor to put the appropriate investment into market studies, marketing, and further technological development. For that reason, it is frequently suggested that licensing should occur by preference to smaller firms but only after proper "due diligence" examination of their capacity, and only in cases where the firms are themselves capable of doing R&D.

The second major issue regarding licensing is the question of expertise. Good technology transfer expertise is extremely rare anywhere in the Government. Laboratories do not have budgets for this as a general rule and scientists are not trained for such a function. As noted earlier in the section on the Process of Technology Commercialization, the expertise required consists of being able to identify technologies of potential commercial interest, evaluate them technically, legally and commercially, and strike suitable deals in the market place. This combination of talents is uncommon in the private sector in Canada and is extremely rare in government. Laboratories need access to these capabilities and need designated people whose job it is to service each laboratory, interacting with the staff. For this to happen, there needs to be a budget in each lab for either creating or buying such expertise. The role of Canadian Patents and Development Ltd. (CPDL) is particularly pertinent here.

CPDL is mentioned by virtually every department in either a positive or negative way. While some, but certainly not all, feel that good legal capability is present in CPDL, most are dubious about its capacity for market assessment and marketing. It is clear that either CPDL must be permitted to build a central source of expertise for the laboratories, or else the large laboratories must be permitted to build this on their own, while the small laboratories use whatever outside brokerage help they can buy. Building a central source of expertise at CPDL makes considerable sense since it would permit "critical mass" and "one-stop shopping". A revamped CPDL could go a long way in establishing linkages between the Canadian venture capital industry and government laboratories. Furthermore, it will be difficult for the Government to determine real costs if the services are decentralized. On the other hand, a laboratory-centered service might be better integrated with the staff and managers of a given facility. Irrespective of which method might be preferable in the abstract, it is clear that certain large agencies, such as NRC and CANMET want nothing more to do with CPDL, reorganized or not, so options may well be limited.

The third and most important matter dealing with licensing has to do with the distribution of revenues. Almost every laboratory complained that the **payback to the lab and to the scientists was so low that there was little or no incentive to promote successful licensing.** The insidious damage done by this lack of incentive has been, in total, utterly devastating. With no real reward for a successful license, the following situations come about as a natural consequence:

1. Projects are rarely designed with an eventual license in mind and therefore usually do not produce transferable technology.

2. Busy scientists find it does not pay to use time to assist in marketing the license (or the product).

3. Far from having their commercial successes applauded, scientists are criticized for "wasting" time on commercial matters of no value to the lab; career advancement remains based on publications or delivery of scientific papers.

4. Labs are glad to see their inventions licensed and have no incentive to demand market prices. Licenses are therefore under-priced and are frequently purchased by firms who feel no need to actually use them.

5. Since business considerations seem irrelevant, patents are frequently obtained (at considerable expense) for "vanity" purposes, distorting the entire process and causing technology transfer programs (including CPDL) to register financial losses.

Clearly, many of the above listed problems apply to all forms of commercialization and not just to licensing. The absence of proper incentives is a crucial flaw, no matter what model of management is applied in each situation. **There is no purpose in any policy being adopted or money being spent to foster the commercialization of technology unless the laboratories (and the scientists) can keep a much more significant portion of the financial benefits that** attend successes. For the scientists the rewards can be financial and/or more travel, study leave, vacation, money for their projects, etc. In this regard, most universities have found that direct financial rewards work best, as long as they are substantial, but prestige and indirect rewards are also important. Rewards to the laboratory can be in the form of discretionary spending on new equipment and new scientific initiatives, i.e. money added to the annual budget.

3. Dissemination of Knowledge

Many of the benefits, both economic and social, derived from government research are created by means of conveying new knowledge to the scientific community, to possible users, and to the public at large. In addition, there are the important benefits gained by providing up-to-date knowledge to regulators and legislators so that they can carry out their mandates effectively. In fact, it would be fair to say that the largest portion of benefit expected and obtained by the public from government research falls in these categories.

The methods used are scientific publications, attendance at meetings, lectures and demonstrations, cooperation with extension programs, media interviews, advertisements, and so on. As a general rule, these appear to be working well. Their success or failure depends more on the quality of work done than on the management model adopted. Spreading information and advising regulators has enormous economic development impact, and is a type of commercialization of technology for which credit is given to both the labs and scientists who participate.

From a narrower viewpoint, publication in scientific journals and periodicals has occasionally led to new commercial interest in marketing the product of the research. On the other hand, it has just as often been the case that premature publication has prevented patenting and thereby discouraged potential investors. Publication is vitally important, of course, for personal satisfaction, for diffusion of knowledge, and as a means of assuring entry for our government scientists at the highest levels of international scientific exchange. Needless to say, Canada obtains more information by being part of the international scientific community than it may lose by the occasional premature publication. The answer is to undertake timely patenting so that the publication does not interfere with eventual commercialization.

4. Miscellaneous Techniques

There are many other techniques used which pertain to commercialization of government research. They each have their place, depending on circumstances and depending on the nature of the lab and the receptor industries. A few which show up repeatedly will be touched on here.

A. People Transfers

Industry scientists are often encouraged to spend time in government labs and, on occasion, government scientists go on an interchange program to work in a related industrial setting. These are beneficial and should be encouraged.

Sometimes key personnel leave permanently to take a job in the private sector. On occasion, this can be the means of very effective technology transfer. At other times, it represents a serious and possibly unncessary loss to the lab. Experience at universities indicates that, with greater flexibility, many scientists would prefer to work part-time in the private sector (e.g. in the new company) while retaining part-time employment in the lab. In theory, this is possible in government laboratories, especially NRC, but it is so difficult in practice that it is virtually never done. People do sometimes take a leave of absence to work with a new firm but this too is almost always on a full-time basis. If more flexbility could be introduced into leaves of absence from government labs, the results would probably be much better for all concerned.

B. Provision of Facilities

Highly specialized or general research facilities are made available by various departments to private Canadian companies. Along with the use of the facilities, there is usually expert advice and guidance offered to the user. Obviously this qualifies as a form of technology commercialization and can be very helpful to firms in appropriate circumstances. Where market rates are charged for the space and equipment used, there is a clear indication that users believe they are deriving real value. Where rentals are non-existent, such as in the form of so-called "incubators", or where they are heavily subsidized, there is a presumed benefit to industry inasmuch as the costs of setting up their own facilities are avoided. On the other hand, start-up companies usually need a type of R&D help that is strictly short-term and product-oriented, something they might not get from science-oriented government researchers. The latter could inadvertently sidetrack the clients into attacking other problems and planning even better products for the future. Occasionally, there is even the problem of working hours since start-up companies might require access on a 24 hour basis and this can be difficult in some government labs.

For more mature companies, use of government facilities at a reasonable rental is generally very beneficial and tends to result in successful transfer of know-how. More mature companies are typically in the lab to use the facilities rather than to have government scientists influence their product development. They are often in a strong position to share knowledge and to take away what they need.

C. Research Partnerships

In addition to the secondments from private industry and the contracting-out already discussed, it is an increasingly common practice in some laboratories to take on research projects that are co-funded with private companies and/or in which the companies' contribution is in the form of personnel. Not only does this permit projects to be undertaken that could not have been managed by the laboratory itself, it also brings fresh blood to the facility and creates a built-in avenue for the eventual commercial exploitation of what is produced. The success of this mechanism logically depends on what its real purpose is in any given application.

Recently, there have been occasions where the project is primarily designed by the government lab, and the role of the firm is just to augment, under contract, the person-years available to the lab. This often has a technology transfer aspect inasmuch as the contracting firm may obtain a license for the intellectual property rights to whatever is developed. It is too early to judge the success or failure of this type of arrangement, but it is unlikely that it will result in much commercialization of technology, given that the intent was not primarily related to that function.

In contrast, there is the situation where a given firm has a real need to undertake some important research, but requires the partnership of a government lab in order to have access to its knowledge and/or equipment. With the firm setting the agenda, and with costs shared, such partnerships are much more likely to result in usable products. This is a type of contract research (see below). Such arrangements are also still too new and too infrequent for judgments to be made, but they appear promising. The key issue here is the need to avoid a given firm having an inside track with a given lab, thus receiving both a hidden subsidy for its research and a competitive advantage over other Canadian companies.

There is no standard arrangement and many forms of ad hoc "partnerships" are in existence. This is not entirely satisfactory inasmuch as the arrangements are often entered into at a lower administrative level in the lab and can have an "old boys" network aspect to them. At the very least, these partnership arrangements should be made on an open and equitable basis, available and publicized to all firms in a sector, and **arranged at the departmental management level** R-14
to guarantee both the propriety of the arrangement and the maintenance of the department's priorities.

D. General Marketing (esp. Contract Research)

Several labs and/or departments have set up **marketing divisions**. whose primary goal is to interest users in assigning **contract research** to the lab or entering research partnerships with its scientists. Such initiatives seem entirely logical, and have great **potential**

for expansion, including into foreign markets, but close accounting will be necessary to see if the services being marketed are being priced appropriately and used beneficially. In addition, IRAP officers throughout Canada are very helpful in informing people as to what is available in government laboratories.

CONCLUSIONS

As stated earlier, given the wide variety of laboratory missions and the enormous differences between various sectors of Canada's economy, there is no single formula which can guarantee the best results in all situations. **What is required is the ability to categorize accurately each scientific facility and to apply the appropriate models, policies and instruments in each case.**

In categorizing the facilities, it is important first to define clearly the main mission of the laboratory and then to make a realistic assessment of its technology commercialization potential. In doing the latter, account needs to be taken not only of the strengths and weaknesses of the lab, but also of the receptors that exist or can be created.

From the foreign and domestic experiences reviewed in this report, it should be pretty clear what the **factors** are that tend to encourage successful technology commercialization and which models will foster those factors. The key task is to choose for each lab the management model that does **the most to promote commercialization** while doing **the least to interfere with the main mission** of the laboratory. It is to ensure that this task is properly undertaken by each department and agency, that existing policies (and procedures) must now be reviewed and changes introduced.

Factors that Promote Commercialization of Technology

This report finds the following eight factors to be of importance:

1. A clear statement of mission, including a technology commercialization component, and a budget to develop or purchase expertise in technology commercialization activities (including technology transfer).

While virtually every lab has some sort of mission statement, it is important that this be reviewed and brought up-to-date in terms that are sufficiently clear to permit straightforward evaluation of success or failure. **R-9**

Even if the main mission is to support the regulatory activities of a particular department or to perform leading edge research in a particular field, there should be an economic development component which should include a technology commercialization objective. Labs develop ideas for new ways to carry out their work and these can lead to new equipment, software or know-how that can be sold to other labs and even to non-laboratory markets. Their techniques may be such that they could do contract research and/or testing for other clients and for other countries. **There is no such thing as a lab that has zero commercialization potential.**

It is essential that there be a budget for each lab earmarked for the commercialization function. A person or group of persons can then be held accountable for the success or failure of these activities. The budget can be used either to develop in-house expertise in the commercialization function or to purchase it from private sector "brokers", or both.

The expertise required is hard to find, especially within the government. CPDL could be made a focus for such trained persons but it would require a drastic change from its traditional ways of operating. Instead of changing CPDL, the government has studied it almost literally to death leaving it with no clear mandate for two years. **A radical transformation is needed whereby CPDL's legalistic orientation is changed into one that is entirely commercial.** Given CPDL's previous failings, the government may decide to permit various departments to set up their own licensing and marketing operations, supported by technology commercialization budgets at a department or lab level. Excessive decentralization of expertise is unwise; if each lab spends its own money, however, on technology commercialization, they can purchase the expertise either from a central source or from outside technology brokers.

2. A well defined client (or clientele) with specific requirements and expectations:

It is interesting that the study by Lord Rothschild in the UK (1971) came to the very same conclusion. He called it the "customer/contractor" principle (we prefer the term "client-supplier"). While he felt that 10% of the research in a government lab could (and should) be "general" i.e. not directly in line with the requirements of the client, the rest should be strictly governed by a client or "customer" relationship.

Very few government labs are (or should be) doing entirely basic research. Apart from them, every lab should have a client (or clientele) who purchases specific deliverables from the laboratory.

Very few things are worse for a government lab than a non-demanding client, uncertain of what it wants or what it can expect to receive, but playing the role of financial supporter.

While efficient client-oriented labs do not guarantee better commercialization, inefficient, non-client-oriented labs are almost certain to be uninterested in or incapable of commercial success.

It is not the role of this paper to analyze in detail the relationships between departments and their labs, except inasmuch as it affects commercialization. Our theory, for what it is worth, is that **there is a fundamental problem in the role of ADM-Research or D-G Research.** Such a person is looked upon by the lab personnel as their champion who fights for more budget, etc., while he/she should be the person who demands results on behalf of the department. Not only does **this combination of roles make a client-supplier relationship impossible, it guarantees the failure of all attempts to shift research extramurally while budgets are tight.** The Extramural Performance Policy has had little effect so far and will probably continue to be largely ignored. People rarely seek a reduction in the personnel for whom they are responsible; nor will they buy from others what their own people wish to produce. **We reflect here Lord Rothschild's recommendation that the person (e.g ADM) responsible for "buying" research on behalf of the department not be the person to whom the labs are** R-5 **responsible. The latter should be a different person reporting to the DM via a different route.**

In other words, where the only substantial client for a lab is the department itself, the person responsible for this should be a departmental employee reporting through a different ADM from the one responsible for purchasing research. When many of the clients are (or should be) people outside the department, the person responsible for the lab should be a person whose rewards come not from the department but from the commercial success of the lab, as provided for in the various models discussed in the report.

3. **Financial rewards for the facility, and for its management and scientists, whenever successful commercialization occurs.**

No model will encourage successful commercialization unless the labs are permitted to operate on a business-like basis. They have to be able to benefit from commercial success and to make reasonable investments where necessary to ensure such success. Put simply, they must be permitted to respend their net revenues and not have them subject to vote-netting. The Technology Centres Policy calls for 20% of net revenues to be returned to the lab but this is far too small. **Labs should retain no less than 100% of net revenues, once all expenses are accounted for (e.g. patenting costs, marketing costs, etc.).** With this incentive, labs will negotiate business-like marketing and patenting arrangements with CPDL, private sector brokers or other agents. R-4

For individuals, the Public Servants Inventions Act is far too limiting. Successful scientists should be allowed to be paid in shares by new companies and to become wealthy as a result of their inventions. This would be a stimulus to commercialization activities throughout the Public Service. Obviously this would not apply when the scientist was still working to regulate the very industry which commercialized his/her invention. R-7

4. **Non-financial rewards, including prestige, career enhancement, travel and other benefits, for scientists who are successful in technology commercialization.**

This can be achieved as a result of the escape from vote-netting, as recommended in Number 3 above. Most new models have these rewards built in and government itself is not impeded from such actions as long as the new net revenues are retained for those purposes. R-13

It is noteworthy that proposed revisions to the classification standards for the Research Scientist sub-group recognize technology transfer activities as having equal status with other criteria, such as publications. This is a very heartening development.

5. **Contracting with Canadian firms to do product development work, followed by purchase orders for the product itself.**

6. **A source of funding for prototype development.**

These are key components of many of the successes reported by the labs and have been discussed in detail earlier. The **Unsolicited Proposals (UP) fund** needs to be reinstated, at least in part, or else a substitute is **R-17**
required in order to permit labs and contractors to work together, at low financial risk, to develop **products** needed by government. The **Source Development Fund** of DSS, also canceled a few years ago, was another excellent method for funding prototypes and for channeling government procurement in a way that fostered new and threshold firms in technology-related areas.

As stated earlier, **a product orientation** is extremely important to labs and can help avoid excessive **R-11**
expenditures on aimless or overly sophisticated research or on products that are not marketable.

It is not the job of government labs to produce products. They do the research to a certain stage **with a product in mind** and there is a key moment when the private sector needs to be engaged to help finish the job. This applies to products needed by the department. On the other hand, when a government invention is offered for general licensing, it may turn out to need further development in order to attract licensees. Again, some mechanisms like a UP fund is needed whereby a licensee (or the lab itself) could receive assistance, repayable out of royalties, in order to enhance the marketability of the invention.

It is important to mention in this regard the matter of **Intellectual Property rights for Contractors.** It is clear that contractors are usually in the best position to exploit such rights but the Crown, having paid for the development of the invention, has a legitimate right to receive royalties and to demand performance requirements from any licensee. It is proposed therefore that the Public **R-8** Servants Inventions Act be amended to permit contractors a right of first refusal on any exclusive license, subject to commercial level royalties and strict performance requirements.

7. Management trained in and enthusiastic about technology commercialization.

We are not familiar with existing training programs for lab managers but we believe they can be arranged by technology brokers and venture capitalists. The goals, as described earlier, could include understanding of how one identifies, assesses, protects and markets technology and some appreciation of how business plans are created and how venture capital markets operate.

8. Maximum flexibility for personnel to move back and forth between labs and private sector opportunities, on either a full or part-time basis.

Personnel policies regarding science and technology have recently been developed to remove certain anomalies in the area of promotion, partial retirement, and recruitment.

Similar flexibilities should be obtainable regarding part-time variable leaves or secondments, or rights-to-return (in the case of some of the new models). It would be useful for Treasury Board officials from four of its Branches, (Administrative Policy, Personnel Policy, Program, and Staff Relations) to meet together to find a way to create this flexibility where research commercialization activities are concerned. R-6

Effect on Receptors

Even if all of the eight factors described above are in place, the commercialization of technology will be impeded by the poor receptor capacity described earlier. It is not within the mandate of this report to suggest how that can be remedied. Nonetheless, the appropriate handling of the eight factors would lead to more spin-off firms (new receptors), better products (with better packaging) for existing receptors, and more interest in government labs on the part of venture capitalists. In time, this would make some improvement in Canada's receptor capacity and while this should certainly not be overstated, it is still of real value.

Fitting the Right Model to Each Lab

While we have looked at various ways to categorize government labs, including those used in the Decision Framework (MOSST), we believe that the Technology Centres Policy is correct in its selection Criteria (Section 6.1.1.). The important typology to begin with is whether a lab is or is not a "Technology Centre" by those criteria. **The key matter is whether the lab has any significant clients (or potential clientele) apart from its own department.** R-2

If the department is the only client of

significance, the lab is not a Technology Centre. In that case, technology commercialization is still important, and should be enhanced by the eight factors (and underlying policies) outlined earlier, but the new models do not apply.

If the lab is a Technology Centre, then one of the management models considered earlier should be implemented as soon as possible. Again, implementation of R-3 a new model goes hand-in-hand with the eight factors mentioned. The models enhance the factors; the same policies which encourage the factors are also necessary for the models to work. New models would apply in almost all the laboratories of the National Research Council, parts of the laboratories within EMR, Agriculture, Forestry and, to a lesser extent, Fisheries. It would also include individual units that have a strong technology and product orientation but which function inside larger groupings whose orientation may be different. Such units exist in the Departments of Communications, Transport, National Defense, and Environment, among others.

For these labs, whose main purpose is to serve the **industrial development** of the nation (even while simultaneously serving at times a "custodial" purpose), it is clear that **the eight factors listed earlier can only be brought to bear by means of new management arrangements.** Industrial development is not a leisurely process. The speed with which technology must move from concept to product is rapid and accelerating. **Management styles, incentive systems, and accountability methods that make sense in many parts of the Public Service are absolutely out of place in today's competitive market place.** Subject to the limitations and shortcomings of each model (as discussed earlier in this report), **any of the alternative models would be better that the present situation.**

As summarized in Table 2, the technology centres should be divided along a continuum of potential profitability from new sources of income. This continuum corresponds exactly with the degree of autonomy that management requires. Within each category of profitability/autonomy, the choice of model will depend on specific factors that typify the situation of each facility.

I. Technology Centres of Low Potential Profitability

i.e. The Department would have to continue its present expenditures in the lab for a considerable time if guarantees were to be given that no layoffs would occur; potential for new clients and new income sources is real but the proportion of new revenue would be relatively low for at least a few years.

For such centres, the most appealing models would be as follows: 1) If contract research from identified domestic sources would be the main income source, the Fraunhofer model would be excellent; 2) If the lab needs a cultural shift to a business environment and if the main clients will require strong marketing in order to be attracted (i.e. new firms, foreign clients, etc.), the Incentive-Based lab (Radian) model might be best since it introduces outside management, supervision and access to venture capital and technology transfer expertise; 3) If conditions in (2) apply, but management is already business-oriented, Employee takeover could be the model of choice. Either (2) or (3) could be first steps to greater autonomy in later years.

II. Technology Centres of Medium Profitability

i.e. The Department's contribution could, if desirable, be somewhat diminished in the near future and the lab would still be profitable without layoffs.

The best models in this case would be the following:

1) The same 3 models and comments apply here as for Section I (Low Profitability), namely Fraunhofer, Incentive-Based (Radian), and Employee Takeover.

2) If the obvious major client would be a trade association, the cooperative model (like Forintek) could be used, bearing in mind the limitations that have been evident with this model so far.

3) If most of the non-departmental clients are other parts of the Federal government, the Operating Agency model is probably best, provided there are a few non-governmental clients and the possibility of some outside competitors as well.

III. Technology Centres of High Profitability

i.e. The lab would be an attractive profitable venture without layoffs even if the department gave no guarantee of continued purchases of research from it.

The best models would be as follows: 1) Outright privatization makes the most sense; 2) If there is a compelling public policy reason why the Crown must own the shares, Crown Corporation status is next best; 3) If most of the new customers are other parts of the federal government, Operating Agency status would be excellent; 4) If prospects are good but considerable uncertainty remains, then either the Incentive-Based (Radian) Model or the Employee Takeover could be implemented, possibly as a preliminary to total privatization later on. In choosing between the two, the

Table 2
Choice of Model

Non-Tech Centre; Department Is Only Client	TECHNOLOGY CENTRES: I. Low Profitability*	II. Medium Profitability*	III. High Profitability*
No Model. Many Policy Changes. Client - supplier basis.	1. Fraunhofer--→→→ if contract research.	→1. Same as for I.	
	2. Incentive-based→ (Radian) - if business expertise needed.	2. Same as for I.→→→	→1. Same as for II - only if profitability in question (ie. 1st step)
	3. Employee →→→→→ takeover - if already entrepreneurial	3. Same as for I.→→→	2. Same as for II and as for 1 - above
		4. Industry Cooperative - if Trade Assoc. is obvious client.	
		5. Operating →→→→→ Agency - if other government clients are users.	→3. Same as for II.
			4. Crown Corporation - if public policy demands
			5. Outright Privatization - Best Option

* Please see text for definition of profitability categories.

severity of need for outside business acumen and culture should be determined.

Policy Considerations

From what we have seen, existing policies seldom stimulate and often impede the development of the eight vital factors listed in the previous section.

For example, changes are required in the **Public Service Employment Act** and the **Public Service Staff Relations Act** to make flexibility and mobility for employees less difficult. **Vote netting policies** of Treasury Board need to be altered so as to offer real financial incentives for the labs and for individuals. There should be no limits to Awards to Inventors under the **Public Servants Inventions Act.** Awards are now so minimal as to be disregarded when decisions are being made. The **Unsolicited Proposals Program,** one of the rare ways in which labs, companies and the Government could jointly finance product development through a prototype stage, should be reinstated at least for that purpose. Similarly, the somewhat analagous **Source Development Program,** terminated a few years ago, should be reinstated for purposes of using procurement to improve the receptors for technology in Canada's economy.

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The **expertise** which is required to make commercialization a success does not now exist in the Government. **CPDL** could be such a focus, but it has been without a clear mandate for over two years. Given its many shortcomings, **a radical transformation would make sense.** Commercialization rather than legal protection should be its main area of expertise. **Keeping it paralyzed in a state of limbo has been distinctly unhelpful.** If CPDL has lost its

R-16

credibility and new centres of expertise are to be created in different parts of the government, them a clear indication of the rules for this development is required right now and provision should be made for bringing in private sector assistance for these purposes.

On the positive side, there have been repeated government efforts to put the right policies in place. The Contracting-Out Policy (Chapter 314, Administrative Policy Manual, Treasury Board), the Government Technology Centres Policy, (Circular 1986-58, Treasury Board), the Decision Framework (MOSST 1987) and the Extramural Performance Policy (Treasury Board 1988) have all been laudable efforts at sorting out the government science situation and transferring both research and technology to the private sector. Without question, there is much more talk about commercialization and technology transfer those days and there seems to be a real increase in advisory boards, research "partnerships" and other activities. On the whole, however, real successes are still quite rare and most of the eight important factors listed earlier are still absent from the majority of settings.

The **Contracting-Out** policy was designed to gradually move to the private sector the fulfillment of government needs in the field of science and technology. As described by laboratory spokespersons in this report, there were a few early successes, particularly when it was product development research which was contracted for and when this was combined with the use of the Unsolicited Proposals mechanism and the awarding of Purchase Orders. As originally intended, the policy also allowed for "a unit now carrying out a particular function in-house" to be "directly taken over by a private sector organization which in turn will contract to perform the function". Except for Forintek, at best a partial success, it appears that this has never really happened in the science and technology field. Despite a willingness to give employees leave of absence for three years with a right of priority of re-appointment, and the ability to count those years as continuing service for pension purposes, no other unit has been taken over by a private sector organization under this policy. **In the absence of political will, turf is never yielded willingly. It is no surprise that contracting out has failed as far as devolution of entire facilities is concerned.**

It is interesting that the use of contracting-out in the last several years seems to have taken on a different quality. Person-year limits, along with budgetary restrictions, have led to the use of "contractors" in various facilities. Most of the time, this has been **a simple device to bring in personnel** who are assigned to the labs' own priorities. If the intention of turning over to the private sector the task of filling these requirements was to build a private sector capacity and to augment the private sector's industrial research strength, that is not being accomplished by this device. The main industrial benefits occur when the private sector contractor is asked to produce a real product, or asked to operate the lab as a business, not simply to act as a means of obtaining personnel in an otherwise restricted employment situation.

Even worse, since it is true that to contract out certain research work from a lab means that the lab needs the expertise in house to evaluate and supervise the contract, the policy is used as an excuse to grow the in-house components even larger in order to do some "contracting" at the margin. The same does **not** apply in the case of contracts for **products** needed by the laboratory.

In view of the fact that the Contracting-Out Policy has never been taken seriously and has, if anything, been **R-1** misapplied, it might as well be withdrawn. Subsequent policies, discussed below, have pretty well rendered it obsolete anyhow.

The **Technology Centres Policy** is designed to "commercialize the operations of various federal laboratories". The declared means for achieving this commercialization include "involving clients more fully in the management", "fostering effective technology transfer", and "facilitating the gradual privatization of certain Centres, where appropriate". As stated earlier, the selection criteria for designating a lab as a "Technology Centre" make excellent sense, as does the concept itself.

Once certain laboratories were designated as technology centres, they would be expected to establish meaningful advisory boards and to demand higher financial contribution from users. At the same time, such centres would be given an incentive by being permitted to keep 20% of incremental outside revenues. The results have been, at best, a mixed picture. Advisory Boards are certainly more common and more active than they used to be. Industry contributions are very marginally higher in some instances. Nothing has been privatized and no management has been contracted-out. As to the 20% incentive, it has been responsible for some additional activities, particularly at NRC and CANMET, but has been uniformly criticized as "far too small" to bring about a major change in operational behavior. This is especially true where licensing is concerned; royalties via CPDL are usually so small that a 20% portion would rarely pay for the administration involved in receiving it. Furthermore, there are no incentives under this policy for the **individuals** who succeed in commercializing technology.

In sum, 1) the trouble involved in being designated

a Technology Centre is greater than the current potential reward, and 2) the requirements of such Centres (Boards, contributions, etc.) are helpful but not nearly as effective as a new management model would be in establishing a pro-commericalization environment. The policy would be far more effective if 100% of new net revenues would be returned **R-4**
to the Centre and if each Centre were obliged to operate **R-3**
under one of the recommended models.

In the Decision Framework, the intent is to analyze government science according to its purpose (economic development, mission-oriented, knowledge enhancement) and to turn over to universities and the private sector as much of the research as possible. The plan is to have regular reviews of each Department to check on progress. This review appears to be taking the form of reports under the Extramural Performance Policy, which provides for new science activities to be performed outside government and for on-going activities to be either justified as in-house or else performed extramurally.

It is certainly far too early to judge the effectiveness of this program. It is questionable whether bureaucratic demands for justification and reports will produce meaningful changes.

One can predict many reports, meetings, and fruitless arguments about what the real purpose of each piece of research may be. Labs will resist central agencies' suggestions that they hand over functions to someone else. Especially when dollars are tight, no real extramural performance will occur except for finding some additional user contribution whenever possible without having to undertake serious change. Millions may be spent on "marketing" existing activities but the fact is that they will be marketing the services of people who have little incentive to have their services marketed. **All of this bureaucratic pushing and pulling can be profitably replaced by the simple expedient of insisting that every technology centre be operated according to one of the models outlined in this report and then leaving them alone to get on with the job.** R-3

In that sense, the real framework under which all of this can be accomplished is IMAA (Increased Ministerial Accountability and Authority). Central agencies do not have to prod and supervise once a management model is put in place which is self-regulating. Each ministry can make its own decision once appropriate models have been introduced in each case. As noted above, government policies concerning employment and outside revenues would have to be changed to permit the models to operate. R-6

In summary, the labs that have important technology commercialization potential, with clients other than their own department, should be immediately designated as Technology Centres, should benefit from new freedoms and incentives, and should be obliged to adopt one of the recommended management models as soon as possible. For the rest of the labs, there should be a different reporting system within each department so that a "client-supplier" relationship can be set up to ensure meanginful deliverables, proper accountability and the kind of client-centered attitudes that permit commercialization to occur whenever possible. R-3 R-5

RECOMMENDATIONS

It is recommended that **Treasury Board:**

1. Withdraw the Contracting-Out Policy and replace it with an up-dated Technology Centres Policy, as well as a Client-Supplier Relationship Policy for those labs which are not technology centres (see number 5 below).

2. Endorse the definition of Technology Centres as being labs with clients (actual or potential) other than the department itself.

3. Oblige each Technology Centre to adopt a suitable management model from among those outlined in this report, the selection based on the degree of expected profitability. Set aside the Decision Framework for these labs.

4. Arrange for Technology Centres to escape vote-netting and to retain (i.e. be able to respend) 100% of new net revenues.

5. Ensure a client-supplier relationship for those labs that serve only a given department (i.e. those that are not Technology Centres). To accomplish this, ensure that the person responsible for obtaining research on behalf of the department, and the person to whom the labs report, are two different people, reporting through two different channels.

6. As part of IMAA, arrange for a meeting between four of its Branches (Administrative Policy, Personnel Policy, Program, Staff Relations) so as to remove any impediments to the models outlined in this report. This would include whatever amendments may be necessary to the

Public Service Employment Act and the Public Service Staff Relations Act to ensure maximum flexibility for leaves of absense, rights of return, financial awards, etc.

7. Cause the Public Servants Inventions Act to be amended so that there will be no limits on the amount of money that Public Servants can receive as a result of commercialization of their inventions, and nothing to prevent them from receiving equity shares when appropriate.

8. Further amend the Public Servants Inventions Act to give contractors, subject to strict performance requirements, a right of first refusal on an exclusive license to exploit any inventions they develop while being funded by government. The Crown would retain ownership of the intellectual property.

It is recommended that **Departments**:

9. Clarify and update the mission statement of every lab, including in each case an economic development component and a technology commercialization objective.

10. Arrange for each lab to have a budget for technology commercialization, with strict accountability for results.

11. Encourage a product orientation in the research programs of laboratories wherever possible.

12. Ensure that contracts from labs are mainly used for product development, and that, when purchasing outside R&D, there be a clear plan leading to an eventual product.

13. Instruct all labs to offer non-financial rewards (e.g. traval, promotions, prestige) to employees when successful technology commercialization occurs.

14. Make certain that research partnerships with the private sector are arranged and managed at a senior management level, do not distort the lab's appropriate priorities and are defensible from a commercial viewpoint.

15. Arrange for training programs for all senior research managers, emphasizing the commercialization of technology and including particularly the functions of identification, evaluation, protection and marketing.

It is recommended that **ISTC:**

16. Revamp Canadian Patents and Development Limited, changing its legalistic orientation to one that is entirely commercial and making it a central source of specific expertise in technology commercialization.

It is recommended that **Department of Supply & Services:**

17. Reinstate, or create a suitable substitute for, the Unsolicited Proposals Program, insofar as it applies to prototype development by departments and outside firms working together. Consideration should also be given in this regard to re-creating the Source Development Program to enhance creation of spin-off firms (new receptors).

APPENDIX I

THE COMMUNICATIONS RESEARCH CENTRE

The Communications Research Centre received special attention in the survey work for the following reasons:

- At least three studies have been performed on its technology transfer performance over the years *(1,2,3)*.

  (1) *The Communications Research Centre - its contribution to the Canadian economy during the past twenty-five years' and some recommendations for the future - by D.J. Doyle, Doyletech Corporation, Kanata, Ontario. November 1987*

  (2) *Technology Transfer by the Department of Communications - a Study of Eight Innovations - MOSST Background Paper #12 - Ottawa, 1980*

  (3) *Technology Transfer from Government Laboratories to Industry - Canadian Experiences in the Communications Sector - by B. Bhaneja, J. Lyrette, T.W. Davies, R.M. Dohoo. R&D Management Vol. 12 #2. April 1982*

- Its technology has spawned two very successful product-oriented companies, MDI and Gandalf.

- It has influenced an unusually large number of companies it its history, first as a unit of DND and then as a unit of the Department of Communications.