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Technological Innovation Studies Program

Research Report

TRANSFER OF TECHNOLOGY
FROM
GOVERNMENT LABORATORIES
TO
INDUSTRY

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School of Business Administration
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November 1978

Rapport de recherche

Programme des études sur les innovations techniques

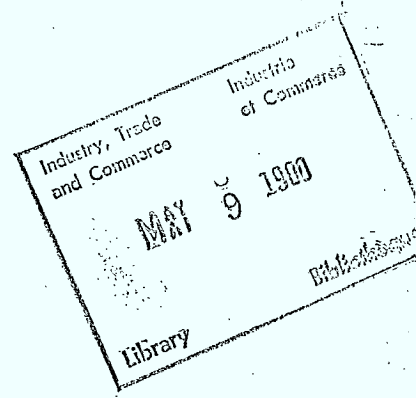


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Ottawa, Canada



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I. Introduction

The investigation reported here was supported under the Technological Innovation Studies Program of the Department of Industry, Trade and Commerce. An objective of the Program is to provide the Department with improved insights in to the technological innovation process in Canada, which can be used in the continued development of government policies to promote and sustain industrial innovation.

Several government reports have been published (for example (1)) commenting on the excessive emphasis of the Canadian economy on resource-based industry and the corresponding weakness of manufacturing industry. In particular, strong concern had been expressed at the small size of the high technology manufacturing industry (such as electronics and pharmaceuticals) and the relatively poor Canadian record for technological innovation. A well-known feature of the Canadian technological environment is the relatively high percentage of national R & D expenditure (as compared with other O.E.C.D. nations) that is spent intra-murally, that is within federal and provincial government research establishments. Because of this comparative imbalance between public and private R & D expenditures, it is conjectured that the innovative performance of Canadian industry is inferior to that of these other nations and that, as a consequence, the Canadian economy is weakened.

In the short-run, it is difficult to increase the percentage of extra-mural national R & D expenditure dramatically, and government must seek to do so incrementally. To this end, two specific policies have been developed:

(i) The 'contracting-out' policy whereby government R & D projects are contracted out to non-government R & D institutions. The policy also allows institutions to suggest their own research projects for government support as 'unsolicited proposals'. It is argued that the long-term effect of this policy will be to expand and strengthen the R & D capability of Canadian industry and hence improve its innovative performance.

(ii) The release of patents and licenses on technological inventions developed in government laboratories to Canadian companies, so that the latter may develop them into commercially profitable innovations. This policy could be expected to improve incrementally the performance of the Canadian economy and to strengthen the technological basis of Canadian industry. Such patents and licenses have been released to companies of varying size but in particular, it was conjectured that the transfer or 'spin-off' of technological 'know-how' from government laboratories might spawn the birth of new small high-technology businesses and promote the development of existing such businesses.

The problems of the transfer of technology from government laboratories to private industry in general, has been the subject of an earlier study by the Science Council of Canada (2, 3), but this study did not focus particular attention on small companies. Small companies may face more difficult problems in 'accepting' and developing technology from government because:

(a) The given technological capability may represent a substantial part or the whole of their product(s). Therefore their commercial survival may be largely or solely dependent upon its successful development to a profitable product.

(b) Such companies have a limited repertoire of technological and managerial expertise and also may be unable financially to subsidize a lengthy product development phase out of the positive cash flows from established products.

These reasons prompted the initiation of this present investigation, which was undertaken within the following 'terms of reference':

The research is designed to identify and evaluate the experiences of small companies which have attempted commercially to exploit new technology developed in government research establishments. A profile of factors which contribute to the

economic success or failure of such companies will be developed through interviews with individual entrepreneurs and government administrators.

2. Companies Studied

Initially it was planned to study just three types of small* company:

(i) Companies founded by ex-government R & D personnel, specifically to exploit technological 'know-how' developed, at least partially, by themselves when working in government laboratories.

(ii) Companies founded by third parties, specifically to exploit technological 'know-how' developed in government laboratories.

(iii) Existing small companies which undertook to develop to commercial fruition similar technological 'know-how', obtained under license from government through Canadian Patents and Development Ltd. (CPDL).

At an early stage in the investigation it was decided to expand the sample frame to include:

(iv) Companies receiving government technological assistance through the government R & D 'contracting-out' policy.

Many of the companies in the sample frame (that is, types (i) to (iv) above) also inter-acted with government in one or both of the following ways:

*No rigorous definition of 'small' was adopted by the investigators, however, most companies studied employed less than 50 people and had an annual turnover of less than \$5 M.

(a) They had received help from other government technological assistance programmes. (Such as I.R.A.P., I.R.D.I.A., P.A.I.T. etc.).

(b) They had successfully bid for contracts to supply government departments with high technology manufactured products to specifications set by government R & D personnel.

Any aspects of the experiences of the companies in these contexts which were pertinent to the main thrust of the study, are also reported.

3. Method of Approach

From discussions with federal and provincial government personnel, a sample of companies fulfilling the criteria defined in Section 2 were identified. Each company was then approached to request if a senior manager within it (usually the president or a vice-president) would grant a personal interview to one of the two principal investigators. Less than ten percent of the companies approached refused to co-operate. The requests were made by telephone, and in the few cases where the interview request was refused, the discussions suggested that the companies were unsuitable for inclusion in this study.

A total of fifty-eight companies were interviewed and forty-six could be classified as being of one or more of the four types listed in in Section 2 above. These forty-six companies were classified as follows:

Types (i)	7
(ii)	10
(iii)	27
(iv)	8

Note that the sum total (fifty-two) exceeds forty-six, since six companies could be classified as having more than one type of experience.

The personal interviews were conducted in an informal and unstructured manner and (in most cases) were tape recorded, using a small portable cassette recorder. The focus of the interviews were on the problems experienced by the companies in transferring technology from government to commercial application. Each interviewee was invited to 'speak his mind freely' on a confidential basis, and to comment on the extent to which policies, procedures and attitudes of federal and provincial governments and other institutions (notable the banking system) promoted and/or inhibited the technology transfer process. Each interview lasted between forty-five minutes and three hours, with most being between one and one-half and two hours. Respondents appeared to welcome the interviews as an opportunity to 'think back' on their experiences with technology transfer and as a socially acceptable, anonymous mode of communicating their views on the subject.

The 'problem areas' which the companies might be expected to face in the transfer and commercial exploitation of government developed technological capabilities were identified from a literature survey and discussions with government officials. Essentially, these areas reflect many of the difficulties inherent in the process of technological innovation plus those that may potentially occur when R & D is transferred from a government organization to a small independent company with limited technological, financial, and managerial resources. These considerations were incorporated into an Interview Guide which provided an underlying framework for the interviews and a checklist for the interviewers.

4. Presentation of Results

In presenting the results of the investigation, the authors emphasize two points strongly:

- a) Firstly, numerous studies on technological innovation have suggested that the prime determinants of the commercial success or failure of such innovations are non-technological. Similarly, in this study, the authors found that a major pre-occupation of most company respondents was with non-technological factors. These were notably, the positive and negative features of government support programmes and the peculiar difficulties which the Canadian situation presents to small high technology companies. Most of these viewpoints have been expressed elsewhere so, to avoid placing an unnecessary burden upon the informed reader, they have not been included here. This report focusses on the interface between government R & D laboratories and small private companies and the problems experienced when technology is transferred from the former to the latter. A subsidiary report (4) is available which describes the government influenced non-technological experiences of the respondents which affect the innovation process.
- b) Secondly, almost all respondents stressed strong and weak aspects of government policies for promoting technological innovation. Since the thrust of this study was to examine ways of improving the commercial exploitation of government R & D through small companies, emphasis is placed on weak rather than strong aspects of government policies. This point should be born in mind in reading the remainder of this report.

The remainder of this report is presented in three sections:

- (i) Section 5 which categorises and discusses the experiences/problems of the companies interviewed, pertinent to the objectives of this study. Wherever possible these experiences/problems are illustrated by anonymous actual quotations of the respondents interviewed.

(ii) Section 6 in which the authors seek to delineate a pattern in these experiences which suggest factors which enhance or inhibit successful technology transfer from government laboratories to the companies.

(iii) Section 7 in which the authors make specific recommendations for improving technology transfer from government R & D laboratories to small companies.

5. Discussions and Comments

5.1 Technology Transfers From Government R & D Institutions to Companies

A consensus of the companies surveyed felt that government R & D establishments were sympathetic towards and supportive of the technology transfer process. However, almost all did experience some difficulties. It appears that many of the R & D transfer problems encountered were similar in kind to those faced by larger companies in private industry when they attempt to transfer technology from their R & D laboratory to their manufacturing operations. The difficulties can be summarized as follows:

- a) Underestimation of the amount of development work still to be performed before manufacturing could begin.

"The first one we got involved in was an instrument to measure...It was given to us as a fait accompli. Apparently it had been produced by a competitor who had not done a good job. We took it over on the basis that it was a complete development and found to our sorrow that it was not and had to be re-organized from the ground up."

- b) Difficulties with the actual transfer of detailed specifications, 'know-how' and 'de-bugging' experiences at all technical (that is, scientist/engineer, technician and design/draughtman) levels.

"The scientist who developed the concept didn't give us much assistance. It was his baby. He didn't want any interference."

- c) Inadequate understanding by government R & D personnel of the interactions among technology, design, production and cost considerations in developing new products.

"Government scientists don't have to worry about marketing a product. They often don't realize that the guy who will have to operate a gadget won't have a Ph.D. They don't know the manufacturing problems of trying to fit a million wires into a saleable package."

"I think the scientist and the manufacturer should work together to build a commercial product that takes into consideration the scientific principle, design engineering, quality that the customer wants and at an acceptable price."

"In earlier years we often received informal help in product development from *** personnel visiting the plant. This meant the product tended to develop along *** ideas rather than the company's. Now with more people we have more R & D autonomy and prefer it that way. We can develop things according to our own ideas. We can and will adapt their concepts to suit our particular conditions."

"People in government laboratories are scientists and not programme directors and therefore, they don't consider such things as purchasing, quality assurance, cost of production or competitive or potentially competitive products."

"The scientist had devised a perfect instrument which was difficult, if not impossible, for a layman to use. I took twenty minutes to take a reading, which is alright for a scientist but not for a business that considers time a real cost. The lab model needs considerable redesigning for quicker readings and must be redesigned to manufacture at a lower price. One of the big problems is that the scientist has no market orientation. He is strictly tied up in his scientific toys."

***: Laboratory or Establishment name here and in subsequent quotations.

- d) Naive and sometimes hostile attitudes of government personnel to industry, commerce and the profit motive.

"Government employees responsible for negotiating contracts think they have done a good job if they can beat us down in the price. We often end up accepting government contracts at cost. No matter what price we put in they'll try to beat us down. They feel it's their duty."

- e) Lack of a sense of urgency by government employees in providing timely technical assistance when problems arose during product development, and inadequate access by the companies to superior testing and measurement facilities often available in government laboratories.
- f) Orientation of government research personnel towards 'publication' rather than towards new product development.

"The objective of government and university research is publish or perish while in industry it is publish and perish. There is a major gap here in objectives between the two."

Clearly, as was stated above, the same problems are experienced in the private sector, but the authors formed the definite impression that the respondents experienced these problems more acutely in their situations. The factors that would tend to aggravate the problems in these situations are perhaps:

- (i) The absence of 'day to day' pressures and even a long-term orientation towards 'profitability' in the government R & D environment.

"The problem of competition with Government-sponsored research bodies is that they can charge less for contracts, do not have to cover overheads or face bankruptcy."

- (ii) The likelihood that government R & D personnel through their career choices may adhere to value systems more oriented towards the pursuit of knowledge and the notion of public service rather than profitability and private enterprise.

"There should be some provision or incentive for government practitioners to go beyond basic work into commercial applications. There is a stigma on profit. Government scientists assistance could be valuable but unfortunately there is a boy scout concept of purity within Canadian Government's R & D."

"Also, when they (Government scientists) do become involved, they are reluctant to be a follower and accept the leadership and direction of the commercial entrepreneur. It seems that if they think themselves scientifically and technically competent then they believe themselves to be commercially competent."

"Someone in Federal Government research is successful if the research is completed on schedule and within cost estimates. The downstream market coming into fruition does not count in his promotion or reward system. Only low risk projects are generally completed on schedule within cost and the more risky, and often more valuable in the market place are passed over."

- (iii) Apart from the goals and values of its individual members, the primary organizational goal of a government R & D laboratory is not to promote technological innovation and profit in the private sector. Therefore it is unlikely to give high priority to technology transfer to the private sector. This is in total contrast to the primary organizational goal of a company R & D laboratory which is, of course, to nurture and sustain the technological basis of the company and generate a succession of commercially successful technological innovations, congruent with the technological strategy of the company.

"There is very little R & D, especially in government, that can yield commercial products. It is a myth that they can do so. There is a lack of quality of R & D in government. It has grown too quickly. Government has tried to build up an R & D base too quickly, not realizing such a thing occurs naturally by evolution ... Canadian Government R & D lacks a direction or a purpose."

"Research is the lifeblood of my company. The head of research receives a percentage of the profits from any new commercial development and therefore he is customer and profit oriented. This is quite different to some lab researchers who do it more for intellectual curiosity than pragmatic reasons. Government and university researchers cannot seem to relate to economic needs. I would not use a government laboratory to assist in developing new products. Scientists who get involved in government service get away from specific responsibility."

5.2 Government Patents and Licenses: Canadian Patents and Developments Ltd. (CPDL).

Since most technology transfer from government to private industry is legally expedited through patents and licenses administered by CPDL, the respondents' comments on this arrangement are reported. On the whole, respondents appeared to find the arrangements acceptable, but there were a few instances of problems:

- a) A few companies did believe that CPDL had misled them as to the market potential and the state of technological development of a new innovation. Although any such misconceptions would derive from government (and, in at least one case, non-government) R & D personnel, because of its role as a 'marriage broker', CPDL inevitably receives some blame for 'unfruitful marriages'. Although they appear blameless in this respect, the respondents' experi-

ences do suggest that CPDL might establish a procedure for obtaining of 'second opinion' as to the technological and commercial viabilities of potential new innovations. Respondents commenting on this point were from Type (iii) companies (see Section 2.1) who suffered significant financial losses which could threaten their survival, through supporting injudicious innovations. Thus, in this situation, government policy to encourage technology transfer could be counter-productive, since it could lead to the collapse of what had previously been a healthy company.

- b) Some respondents thought that the royalty percentage charges of CPDL were higher than normal practice, and that the crown corporation was not vigorous enough in protecting the interests of their companies in foreign countries. One company (which had also experienced the difficulties listed in a) above) believed that CPDL had obstructed the negotiation of an advantageous sublicense with a foreign company. One problem frequently stated by those interviewed was that of patent breeches. Many small companies felt they could not afford to pursue litigation with respect to patent breeches especially when foreign countries were involved. Many expressed the opinion that the federal government should undertake aggressively to pursue litigation in this matter.

"A small United States company infringed on our patent and started manufacturing and selling in direct competition with us. I don't think the patent license agency pursued litigation as fast as it should have. This gave notice to all U.S. firms that the Canadian Government would not enforce patents so, in the future, I think we can expect more patent infringements."

6. Evaluation of the Companies' Experiences and a Profile of Factors Affecting Commercial Success or Failure.

The authors interviewed forty-six companies which fell within one or more of the four types listed in Section 2 (pages three and four) of this report. As was stated earlier (Section 4, page five), respondents were mainly pre-occupied with non-technological factors and so, in general were disinclined to dwell upon the technology transfers aspects of their experiences. As a consequence of this pre-occupation, many respondents may have understated difficulties of technology transfer, because their perceptions of such difficulties were effectively 'masked' or 'swamped' by their other pre-occupations. Whatever the reason however, the authors found it difficult to categorise the experiences of more than twenty-two of the forty-six respondents beyond the level of generalizations given in Section 5. On the other hand an evaluation of the experiences of these twenty-two respondent companies did suggest a profile of factors which influence the commercial success or failure of technology transfer, and we now report this evaluation.

6.1 Type (i) Transfer: Ex-government Research Personnel

The experiences of only three Type (i) firms could be categorized beyond the level of generalisations given in Section 5. All three such firms saw the fruition of technologies into marketable products, but not all of the products in question were successful in the marketplace. None of the interviewees claimed to have difficulty in the technological transfer stage and expressed the opinion that this was due to the 'know-how' being transferred, with the original developer.

Aside from being directly involved in the development of the technology, all of the firms maintained their links with government personnel for several reasons. Each interviewee acknowledged the real benefits from a close working relationship with their previous employer and fellow employees. One of the firms located in the Ottawa area stated:

"Toronto was a closer location to our markets but we set up in Ottawa to remain near one ***lab."

Continuous and lasting contact with the original laboratory of research ensured the firms of proper testing facilities and immediate knowledge of new developments or extensions in the technology area.

It should be noted that one of the firms in this group was founded, not by a researcher, but by a government employee who saw a need for a specific product by his organization with no suitable product on the market. Therefore he left government to set up a firm to manufacture such a product. This firm worked with government scientists from the birth of the technological concept. Contacts with the government agency assured the license for production of the new firm. Contact with both the agency and the laboratory are being maintained. It is noted here for later reference (Section 6.4, page 20) that this firm has only one customer and one product line.

The firms offered different explanations for the difficulties they experienced once their product was ready to market, but two major explanations stand out. Lack of funds to exploit the market and lack of market to make the product a worthwhile commercial venture. Both of these explanations suggest a lack of business planning as a reason for difficulty or failure. Two of the three firms, however, showed strong signs of building a stable business. Efforts were being made to become aware of market needs and sizes and product lines are being expanded into areas which reflect a widening and deepening technological expertise within the firms.

6.2 Type (ii) and (iii) Transfers: Technology Transferred to New Companies not Set Up by Ex-Government Personnel, or to Existing Companies.

First of all it should be noted that the authors found it difficult to distinguish between these two types of company. A company set-up

'from scratch' to develop government technology could be clearly categorised as Type (ii). However, when the technology being transferred was so radically different from a company's existing technological or market base, that a new management and technological personnel team were recruited to develop the new venture with considerable autonomy, its classification as a Type (iii) as against Type (ii) is debatable. This argument, plus an inability to delineate differences in the experiences between these two types of company, has lead us to treat them as one category, in this discussion.

The experiences of eleven Type (ii) and (iii) firms could be categorized beyond the level of generalisations given in Section 5. Such firms can initially be categorized by their intention in acquiring a license. Firstly, there are those firms (four out of the eleven) who were looking for a 'profit opportunity' through a potential readily manufacturable and marketable product. Without exception they appeared to experience complete failure: not only in putting together a marketable product, but in the transfer of the technology. Firms experiencing such failure claim to have been "sold a bill of goods" by CPDL. Their complaints that the technology was incomplete or inadequate suggest that they did not critically evaluate and assess the technological development required to bring the product to the marketplace.

A common characteristic of these firms appeared to be that they lacked initially (and failed to try to establish) an inter-action with the laboratory of original research. Two of these firms each experienced two such failures. In contrast, a third such firm recognised this weakness after one such failure and undertook to inter-act closely with the government scientists working on their next license acquisition. This latter firm claimed better 'luck' with its second license and predicts faster and better transfers in the future.

The remaining seven firms in this category, all displayed similar attitudes and behaviour:

Close relationships with the government laboratories were considered critical in the success of a license. One firm based in Southern Ontario has a permanent office in Ottawa through which it maintains direct contact with government scientists working in the firm's technological area. Even so, the firm experienced some difficulty in bringing home the technology to Southern Ontario, therefore it increased its Ottawa staff to provide a continuous shuttle between the two locations. Some interviewees claimed that a personal-social level of intercourse with the government laboratory scientists was the best way to accommodate the transfer.

Only two of this sub-group experienced difficulty in timing the production-readiness of the product. One was delayed and one was early (in the sense that the market and marketing was not yet ready). This timing expertise reflects an awareness by the firm of its skill at effecting transfer and an initial understanding of the technology involved and the market potential. Further, the firms display their business acumen with respect to the needs and readiness of the market, and to their long term product planning (lead times run from three months to eight years).

What was apparent to the investigators is the fairly obvious point that companies with a 'bread and butter' line (i.e., an established product with steady sales) were better able to support the development of an innovative product:

"Our company survives on the revenues generated by a very successful product. The product we would like to develop, the product that we feel has great potential, is being supported in its developmental stages by our bread and butter line".

"Financing was not a problem since the other lines within our company could cover any R & D cost and the cost of setting up a marketing distribution programme to handle the product."

It can present problems however, until the 'bread and butter' line is fully established. One Type (iii) company president interviewed, who is adopting this strategy commented that until it is established, the

'bread and butter' as well as the innovative product, requires his continued attention if it is to succeed. He found that salaried employees with no stake in the equity of the company were unprepared to give the commitment required to ensure its success. His observation suggests that this strategy may only be viable if 'owner-managers' ensure that they have the skills and time directly to manage both product developments. It also suggests a broader generalization. Individuals with the 'product champion' and entrepreneurial drive to generate new high technology businesses are unlikely to seek a purely salaried employment in a small business. They are more likely to seek either such employment in larger businesses whilst enjoying greater job security and gaining valuable experience, or to set up their own small businesses. This suggests that in small high technology businesses the 'owner-management team' should be large enough to ensure that it can supervise directly all product developments until their management can be prudently delegated to purely salaried employees.

All of the successful seven firms displayed an awareness of the 'product-life cycle' concept. These firms experienced difficulty in new capital acquisition, but little difficulty in cash flow. Many referred to their 'bread-and-butter' lines when in fact they were describing a continuous change in a product line so as to maintain a cresting effect through the sequential maturing the life cycles of their products.

Two of the firms explicitly commented on the necessity of 'developing the market' at the same time as developing the product. This 'development' is found in both active and passive forms. The passive form involves an intimacy with the firm's current and potential customers and their needs, and the continuous exercise of looking in the government laboratory for new applications. The active form manifests itself in market intelligence and anticipation. One firm foresaw the demise of the semi-conductor industry in Canada (upon which it was dependent) and planned well in advance for a complete change in technological expertise. Many firms actively searched for new technological areas compatible with their own technological and marketing capabilities.

In summary then, the successful experiences with licenses are characterized by:

- a) Close, continuous relationships with government laboratories and scientists.
- b) An awareness of the firm's lead time between initial contact with a technological development and product readiness.
- c) An awareness of the business concept of the "product life-cycle", and
- d) An awareness of the needs and readiness of the marketplace.

6.3 Type (iv) Transfers: Contracting Out

This type of company (there are eight considered here) is similar to type (i) in that the company laboratory is the laboratory of original research. The technology transfer from government is present, however, both in the form of the transfer of an idea or need and in the form of direct financial support for research. There are two types of companies involved in this transfer category: The firm involved solely in research, and the firm involved both in technological transfer and the acquisition of the CPDL license.

The former (one out of the eight) works closely with a government agency and 'stays on top' of the agency's needs. Production is geared to the government agency's limited requirements. This firm admits to not being 'sure of markets' and appears to lack either the entrepreneurial drive to take a risk or the business know-how required to develop a market. The latter seven companies actively seek out a commercial market and are continuously working on technological spin-off.

This latter group of firms are characterized by their acknowledgement of the importance of contacts in both government agencies and

government laboratories. With respect to agencies contracting-out research, close contact is needed to ensure awareness of the potential needs of the agencies in order to make a successful bid and further, to use this close awareness of needs when actually doing research. These needs (that is, an awareness of the exact use and manner of use) are often not specifically expressed in the written contract. (This observation is also consistent with the findings of the SAPPHO project (5) which identified 'user needs understood' as the most important determinant of the success or failure of a technological innovation). Further the credibility of the company, that is its technical capability and its employees' ability in the eyes of the agencies' employees, are seen by the firms to be critical in successfully bidding on contracts.

Two further indicators of success in these companies are:

- a) Close relationships with government laboratories are maintained in order to achieve cooperation in testing and use of facilities.
- b) Firms interested in the technological spin-offs and the commercial exploitability (the acquisition of license) display the characteristics of successful companies in Section 6.3.

6.4 Environmental Characteristics of Firms Successful at Technological Transfers

All of the firms experiencing success in the transfer have close and continuous working relationships with the transmitters of the technology. All of the unsuccessful firms did not have it. Transfer is perhaps an inappropriate word for the concept involved. This is supported by the words of one of the most successful firms interviewed.

"There is no such thing as a complete transfer. There is only a sharing and this sharing is a continuous process because development is a continuous process. Our employee in Ottawa is as much ***'s man as he is ours and the same holds for his contacts. *** is very much an integral part of our company."

The development of technology into a production ready product certainly indicates a transfer of technology, but whether or not it is a successful transfer is questionable. Production readiness does not mean marketability. An essential part of government R & D is surely to support and encourage commercial application and to have the results of the technology in the marketplace. If this is so then the technology transfer is incomplete without market success. In order to ensure market successes firms must exhibit all of those characteristics listed at the end of Section 6.3.

With respect to the Type (i) firm mentioned in Section 6.1 (page 14) it is questionable if the firm will survive with a single product and no long term plan for product-line development. If the firm does not survive the technology transfer will die with it, and so can hardly be described as having been successful.

6.5 Profile of Factors Indicative of Commercially Successful Technology Transfer

The analysis of twenty-two examples of technology transfer described in this Section did suggest a profile of factors which could be viewed as indicative of companies which are likely to be commercially successful in technology transfer. This profile of factors can be summarized as follows:

1. The company seeks to establish a professionally intimate relationship with appropriate government R & D laboratories. Our results suggest that this 'intimacy' is achieved as follows:
 - a) The company continuously monitors government R & D activities within the areas of its technological capabilities, to identify potential commercially profitable R & D 'inventions'. Normally such identifications will occur before the 'invention' is released for development as a commercial 'innovation' through a CPDL license.

- b) The company also consciously seeks to exploit the government 'contracting out' policy to build up its relationships with government R & D, to expand and consolidate its technological base and commercially to exploit government R & D.
- c) Whenever possible and appropriate, the company seeks to establish out-stations in government laboratories and the secondment of government R & D personnel to its own R & D unit.

That is the company seeks to make government R & D capability a notional extension of its own R & D capability.

2. The company continuously monitors its marketplace to identify potential opportunities for innovations which may be developed from government R & D. In particular in defining its marketplace the company takes specific note of government changing needs. Manufacturing high technology products under contract to government specifications provides another opportunity to build up closer relationships with government R & D personnel.
3. Either formally or informally, the company practises business planning which enables it:
 - a) To conduct market evaluation and development simultaneously with the product development of the technology being transferred.
 - b) To estimate realistically the development lead-time for the product and the implications of delayed or early entry of the product into the market.
 - c) To understand the role of the life cycle concept in technological innovation. Thus to ensure that the company has an adequate portfolio of products in various stages of the life cycle to maintain its continued financial viability and adequate financial resources to sustain technological innovation.

7. Recommendations

As a result of this study, the authors make the following recommendations:

- 1) Government should review the strategies and goals of its R & D establishments to ensure that they are promoting Canadian technological innovation, insofar as it is congruent with their other missions.
- 2) Although senior government R & D personnel appear strongly to support technology transfer to private industry, our interview responses suggest that this support is not always shared by 'bench level' scientists. R & D staff at all levels should be encouraged to support technology transfer by:
 - a) Ensuring that such staff recognize that performance appraisal will be based upon an individual's record in promoting technology transfer and innovation (whether commercially successful or otherwise) as much as his or her publications record in the literature.
 - b) By identifying the need for any new laboratory roles to promote transfer and innovation. R & D staff who are eager and competent to fulfill such roles should be encouraged to do so and effective performance should be subsequently well recognized. An example of an exercise which can be performed is described in (6).
3. To facilitate technology transfer from government to private companies, government should encourage the secondment to companies of the appropriate R & D staff whilst the specific technology transfer is in progress. Seconded staff should still have their salaries and fringe benefits paid by government. A more positive assertion of such an active policy would be an automatic loan of the prime government researcher involved when a Type (ii) or (iii)

company accepts a license to develop a government invention from CPDL*.

4. Government R & D personnel who wish to explore the possibility of setting up new or join existing companies without surrendering their civil service tenure, should be encouraged to do so. This support could take the form of part-time or full-time unpaid leave of absence (say to a maximum of three years full-time equivalent) without loss of seniority or pension rights.
5. Government should review and evaluate the mechanisms whereby military technological 'know-how' is transferred from D.N.D. R & D establishments to private industry to develop new weapons systems, to determine the extent that similar procedures could be used to promote the transfer of civilian R & D.
6. Government administrative staff concerned with technological innovation and all government R & D staff should be given formal education in the process of technological innovation and the problems endemic in the process at each of its stages. Particular attention should be given to the process of technology transfer from government to private industry and the factors that promote successful innovations.
7. Government should promote similar educational programmes for novice technological entrepreneurs as well as ones on the setting up and managing of small businesses, to familiarize them with the problems of setting up and developing high technology businesses. Attendance at one of these programmes should be a requirement for receiving financial support.

*One of the authors was formerly employed as an R & D scientist in the research laboratories of a major multi-national electronics company working on semiconductors. At that time (1958-60) R & D scientists were expected temporarily to commute on a Monday to Friday basis to the manufacturing plant to facilitate technology transfer from the research laboratories. The authors see no reason why similar arrangements could not be set up for government R & D personnel.

8. CPDL should screen all license applications for the characteristics (or the potential to develop same) listed in Section 6.3. It is suggested that the CPDL treat its licenses like a banker treats his loan money and/or like a financier treats his venture capital. CPDL could, in this fashion, play an active role in reducing business failures.
9. CPDL should monitor the availability of 'off-shore' licenses to identify that extent to which the technological and commercial bases of small Canadian companies can be built up by the judicious exploitation of domestic and foreign licenses. Some of the success of Japanese technology is attributed to this policy (see (7)).
10. Firms who do contracting out R & D should be "encouraged" to exploit commercially the technology they develop. Otherwise, the government agency might as well acquire the firm as a branch of its own laboratory facilities.

8. References

1. 'Background to Invention'. Science Council of Canada, Special Study No. 11 (1970).
'Innovation in a Cold Climate'. Science Council of Canada, Report No. 15 (1971).
'Governments and Innovation'. Science Council of Canada, Special Study No. 26 (1973).
2. 'Technology Transfer: Government Laboratories to Manufacturing Industry'. Science Council of Canada, Report No. 24 (1975).
3. 'The Role and Function of Government Laboratories and the Transfer of Technology to the Manufacturing Sector'. Science Council of Canada, Background Study No. 35 (1976).
4. 'Government Support Programmes and the Canadian Environment for Small High Technology Businesses'.
5. 'The Economics of Industrial Innovation'. Christopher Freeman, Penguin Books, 1974, pps. 171-197.
6. 'Critical Functions: The Key to Managing R & D Staffing in Support of Plans for Technological Innovation'. Alan R. Fusfield Pugh-Roberts Associates Inc. Report.



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1. I.A. Litvak C.J. Maule	Department of Economics, Carleton University.	Canadian Entrepreneurship: A Study of Small Newly Established Firms. (October 1971)
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- | | | |
|--|---|---|
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- | | | |
|-----------------------------------|---|--|
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- | | | |
|-----------------------------------|---|--|
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| 25. M.E. Charles
D. MacKay | The C.E.R.C.L. Foundation
200 College Street,
Toronto, Ontario M5S 1A4 | Case Studies of Industrial
Innovation in Canada. (February
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| 26. M.R. Hecht | Faculty of Management
Studies, University of
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Canada: With Emphasis on Education
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| 27. I.A. Litvak
C.J. Maule | Department of Economics,
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(May 1975) |
| 28. R.R. Britney
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- | | | |
|---|---|--|
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- | | | |
|--|--|--|
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Business in the Canadian Economy.
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- | | | |
|--|---|--|
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S.M. Hills
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University of British
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Japan - 1977
Mexico - 1977
Venezuela and Columbia - 1978
Brazil - 1979 |
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tion et d'économique.
Université du Québec. | Les Stratégies de PME et Leur
Adaptation au Changement (Interim
Report). (Avril 1978) |
| 49. Ilan Vertinsky
S.L. Schwartz | Faculty of Commerce and
Business Administration,
University of British
Columbia. | Assessment of R&D Project
Evaluation and Selection
Procedures. (1977) |
| 50. K.C. Dhawan
L. Kryzanowski | Faculty of Commerce and
Administration
Concordia University
Montreal, Quebec | Export Consortia: A Canadian
Study. (November 1978) Available
at 15.00/copy
Send all orders payable to:
Dekemco Ltd.
Box 87
Postal Station H,
Montreal, Quebec
H3G 2K5 |
| 51. I.A. Litvak
C.J. Maule | York University
Carleton University | Direct Investment in the United
States by Small and Medium Sized
Canadian Firms. (November 1978) |
| 52. R.M. Knight
J.C. Lemon | School of Business
Administration,
University of Western
Ontario. | A Study of Small and Medium
Sized Canadian Technology Based
Companies. (September 1978) |
| 53. M.J.C. Martin
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Administration,
Dalhousie University. | Transfer of Technology from
Government Laboratories to
Industry. (November 1978) |

- | | | |
|-----------------------|--|--|
| 54. J. Robidoux | Faculty of Administration,
University of Sherbrooke. | Study of the Snowmobile Industry in Canada and the Role that Technological Innovation has Played in Its Economic Performance. (English summary only).

Facteurs de Croissance de l'Industrie Canadienne de la Motoneige (1959-1978). |
| 55. R.A. More | School of Business Administration,
University of Western Ontario. | Development of New Industrial Products: Sensitivity of Risk to Incentives. (January 1979) |
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- | | | |
|--------------------------------|--|---|
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Available from the authors.
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Organization in Mechanical
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University of British
Columbia | A Directory of Research
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