Ministry of State
Science and Technology Canada

Ministère d'État
Sciences et Technologie Canada

security classification

cote de sécurité

UNIVERSITY-INDUSTRY TECHNOLOGY TRANSFER

REVIEW OF EXISTING MECHANISMS

1978

internal report

rapport interne

UNIVERSITY-INDUSTRY TECHNOLOGY TRANSFER

REVIEW OF EXISTING MECHANISMS

1978

Forecasting Division

February 6, 1978

I. CANADA

i) Department of Industry, Trade and Commerce (IT&C)

Presently, there are two major programs supported by IT&C which are designed, in part, to stimulate technology transfer from the universities to industry. A brief review of both programs is provided below:

a) Industrial Research Institute Program

This program was introduced in 1967, and was mainly designed to service the numerous industrial needs of a particular geographic area. It was recognized that many industrial firms were too small to sustain effective in-house research and development activities. As well, it was considered that such firms, in addition to larger firms requiring specialized equipment or assistance, might be encouraged to make use of the equipment and expertise of the universities.

The major objectives of this program are two-fold:

1) to encourage universities to provide scientific services and carry out R&D projects for industry;
2) to promote more interaction between industry and university, thus allowing universities a better understanding of industrial problems and industrial awareness of scientific and technical work in universities.

To achieve these objectives, industrial research institutes were formed and given the responsibility to arrange their activities so that they would become self-supporting within 5 to 7 years.

As a result of the program, by December 1976, nine industrial institutes were operating, five of which were self-supporting. The other four were expected to become self-supporting within the next three years. This program is expected to end when funding of the four remaining institutes terminates. Supplementary details on these institutes are provided in Appendix I.

The results of the Industrial Institute Experiment are particularly encouraging, since as yet, the United States has not been successful in establishing regional research centres. Following the Canadian model, the U.S. had intended to support regional centres under the NSF's Experimental R&D Incentives Program. Plans have been delayed, since the NSF has not received any assurance that a regional institute could become self-supporting.

The Industrial Research Institute Program at the university of Waterloo has been a major success story and deserves special attention.

The University of Waterloo has developed an agressive program to generate external funding through contract research. Direct technology transfer from the university to the market place is actively encouraged. For example, the university currently has assigned to it about 65 patents or potential patents. As well, patents have been applied for in seven countries and licensing negotiations with a Canadian manufacturer are well underway.

Under this stimulative environment, the Industrial Research Institute Program has flourished. From 1967 to 1973, Waterloo received a total grant of $244,557. As of 1975, the industrial institute completed its second year of self-supporting operation.

For the year 1975, contracts exceeding one million dollars were obtained and by December 1976 this institute was experiencing greater success in obtaining higher dollar-value contracts. This success is attributed to increased client confidence. An increasing amount of time and effort is being devoted to the practical exploitation of ideas and developments and it is hoped that successful completion will give rise to income from royalties.

Although many of the institutes appear to be financially successful, and technology transfer appears to be occurring, sufficient documentation has not been found in order to properly evaluate this latter objective. For example, no data exists on the number of students and faculty who have been transferred to industry since the program was initiated. If this information exists, it will have to be obtained directly from the managers of the institutes.

b) Centres of Advanced Technology Program

This program was introduced in 1968. It was principally designed to encourage universities and others with research capabilities to establish expertise centres in specific industrial technological sectors.

The major objectives of the program were:

1) to provide industrial assistance in basic and applied research;
2) to provide industrial technical development assistance;
3) to provide graduate and undergraduate training relevant to industrial needs; and
4) to promote industrially relevant research by graduate students and universities.

These centres are expected to become self-supporting within seven years, at which time they are expected to continue to provide industry with the above services.

As of 1976, there were nine research institutes, five for which grants had terminated by December 1976. Reduction in program funding has prohibited the establishment of any new centres although discussions concerning the establishment of further centres has taken place.

Total grants authorized to March 31, 1976, amounted to $6,380,000. and are expected to terminate in 1981. Appendix I provides supplementary details on this program.

As was the case with the Industrial Research Institute Program, detailed discussion with the directors of these centres is required to determine the extent to which technology transfer has occurred. Sufficient published data are not presently available.

ii) National Research Council (NRC)

The National Research Council has two major programs designed to stimulate technology transfer from university to industry. A summary of these programs is provided below:

a) Project Research Applicable in Industry (PRAI) Grants

In 1970, NRC developed PRAI Grants to University Staff aimed at overcoming some university/industry difficulties in

communication. This program provides short-term complementary support for those whose research has already led to the identification of a specific and novel technique, process or product promising to be of commercial value to Canadian industry.

In 1973, thirty-one grants were made and this number has steadily decreased until in 1976 there were only four grants. From preliminary discussions with NRC, it appears that lack of participation rather than lack of money was the main cause for this steady decline in the number of grants. It was also the opinion of the NRC officer in charge of this program that the grants made were worthwhile but that there is just not enough participation on the part of the universities. Currently, NRC is reviewing this program, and a report is forthcoming.

b) Industrial Post-Doctoral Fellowships (IPDF)

This program is designed to encourage highly qualified students who have recently received, or who are about to receive, their doctoral degree, to seek careers with industrial organizations in Canada. Applications are accepted only when submitted by a company on behalf of a candidate.

The number of IPDF's in 1976-77 was relatively small, totalling about 125 awards. Expenditures amounted to about one-half million dollars for this same year. NRC has stated willingness and capability to provide more awards; however, present size and expansion are totally dependent on the limited number of proposals received from interested companies.

iii) Other Federal Programs

There are a number of other major programs which could have indirectly stimulated technology transfer from the university sector to industry. A list and description of these programs are contained in Appendix II. Of particular significance is the Industrial Research Association Program (IT&C). This program is similar to the Cooperative Research Centre Experiment of the United States (see section II) in that the centres are designed to support R&D common to a particular industry. In contrast to Canada, however, the U.S. centres are located at the universities with the added benefit of encouraging university/industry technology transfer. This approach improves industry/university contact; provides a mechanism for both industry and university to use common facilities, thus reducing costs; and provides an environment for graduate students to gain experience related to industrial R&D.

Additionally, programs and mechanisms such as the Industrially Oriented Special Grants (NRC); the contracting-out policy and the recent small business policy have the potential for stimulating technology transfer. Nevertheless, in order to determine exactly which projects and mechanisms indirectly resulted in a university/industry transfer of technology, a case by case review of each of these programs would have to be undertaken. This is conceivably possible, but was not deemed necessary at this time.

II. UNITED STATES

The links between universities and industry appear to have weakened in the two decades following World War II approaching their nadir in the early seventies. The reasons for this are complex, but three principal factors have been isolated. First, the rapid growth of federal funds for academic research gave universities less incentive to maintain or increase their ties with industrial firms. Second, during the growth phase of the university sector, new PhD's chose academia over industry. As well, professors tended to train their best students for careers in academic research. Last, industry reduced its role in basic research in favour of applied research making working relationships with universities more difficult.

Since the early seventies, efforts have been made to improve university/industry relationships. The most effective means of linking academic and industrial research is said to be achievable through consultations and staff exchanges. Beyond this, universities and industry have attempted to encourage close collaboration to improve the knowledge transfer through a number of mechanisms. These include direct corporate funding of university research projects; cooperative research programs; university/industry research consortia; joint industry/university laboratories; technology licensing and technological brokers; development of university extension services; university industrial associates; industrial parks;

innovation centres; and university business development centres. Examples of many of these programs are given in Appendix III.

Of particular significance are the Innovation Centres Experiment and the Cooperative Research Centres Experiment sponsored by the National Science Foundation (NSF).

a) Innovation Centers Experiment

Given the view that the major factor in technological innovation is the entrepreneur, Innovation Centres were conceived as vehicles within universities for stimulating technological innovation and for increasing the entrepreneurial tendencies of graduates as they pursued their careers. These centres offer courses in entrepreneurship and innovation, expose students to the entrepreneurial process and actively promote innovation as an integral part of the academic regimen.

Each of the innovation centers has as a common objective the demonstration that university-based activities can stimulate innovation and entrepreneurship in the external business community.

At present there are three centres, located at the Massachusetts Institute of Technology (MIT), Carnegie-Mellon University (CMU), and the University of Oregon. These institutions were established in 1973 and were awarded a total of three million dollars for five years of operation. These

centres were planned to be self-sufficient after the first five years. The continuation of the innovation centres beyond the period of NSF support appears assured for MIT. At present it is not clear that the other two institutes can achieve self-sufficiency by 1978.

Although it is too early to assess the results of the centres in terms of transfering technology from the university to industry, there are a number of indicators which reflect that the experiment is well on the road.

By the end of 1976, 23 active businesses were initiated or assisted by the innovation centres. Total sales (1975), and backlog (1976), of these businesses was in excess of $30 million. Direct taxes alone (estimated at $16 million) from these ventures already exceeds the total five-year cost to NSF. At Carnegie-Mellon, the centre director estimates that eight dollars in taxes have been created through new ventures for every tax dollar spent by the institute.

The centres have also provided a focal point for credible evaluation of ideas and inventions. In the first year of operation, more than 500 ideas were brought to the centres. Although only a few ideas have been recommended as being worthy of continued development, contact with submitters of these ideas has established that a high level

of satisfaction is being achieved. Because of the need for such evaluations and the apparently inadequate service provided by commercial firms, this aspect of the centres has received considerable public attention.

In a utilization study on the Innovation Centers Experiment, 18 interviews with entrepreneurs, students, venture capitalists, government officials, industry executives and others revealed a supportive constituency. Each of the centres was, in its own way, demonstrating encouraging efficacy in an academic environment.

Enthusiasm by the students is thus far encouraging. In the absence of a student survey, the only measure of success is the extent of student participation. The number of student enrolments expanded from 400 to 700 and the number of courses offered increased from 14 to 30 in the first three years of operation. According to the centre directors, this trend is expected to continue. It should be noted that success of the experiment will only be proven when the entrepreneurship of the student participants is shown to exceed that of a control group. NSF plans to track the participants over a period of several years to obtain the necessary evaluation data.

There should be no misunderstanding; this experiment has encountered numerous barriers. For example, lack of acceptance as total partners in the academic community, questionable financial stability beyond the period of the experiment, ventures that fail and inventions that do not find a market, have been singled out as major impediments to success. On the whole, however, there appears to be enough evidence to consider emulating this experience in Canada.

b) Cooperative Research Centre Experiment (CRCE)

This experiment was established in 1973 under NSF's Experimental R&D Incentives Program. At present, the NSF sponsors programs at three universities: Carnegie-Mellon University, North Carolina State University and MIT. This experiment is similar to the Industrial Research Association Program of IT&C in Canada, in that the centres are designed to support R&D dealing with technological activities common to a specific industry and are to be self-sufficient. It differs from the Canadian program in that the centres are located at universities with the further benefit of encouraging graduate students to work in problem-oriented research directly relevant to industrial needs. For example, the Processing Research Institute (PRI) at Carnegie-Mellon was funded by NSF in 1971 mainly to develop a Master of Engineering program oriented toward the processing industries.

Unlike the NSF's Innovation Centers Experiment, a complete review of the CRCE has not yet been undertaken. However, the following more detailed discussion of the MIT program (where some recent documentation exists) supplemented by recent discussions with the NSF should prove informative.

The Industry Polymer Processing Program at MIT was established with the purpose of identifying and testing federal incentives for improving technological innovation and transfer for the public benefit. Although one of the principle goals of the program was to "recommend alterations in public policy which would result in increased R&D investments and efforts by small firms", the five initial industrial participants were large corporations with annual sales ranging from $40 million to over $10 billion.

The program began with a $100,000 grant from NSF in 1973. By the 1977 fiscal year a total of $874,000 had been expended on the program ($446,000 by industry and $428,000 by the NSF). NSF financial support is expected to terminate in the 1978 fiscal year. It is unknown whether the program can become self-supporting by 1978.

As of 1976, the program was staffed by about 20 faculty, staff and student researchers. Eighteen projects had been initiated, of which 6 to 10 had been active at any given time.

It has been perported that one of the important by-products of the Centre has been the development of student researchers. Particularly important was the experience gained from having to describe a research plan, the applicable theories, the work accomplished and implications of the results. From this experience, students are industry-ready and in demand on the job market. However, it should be noted that no data were available on the extent and success of student participation.

There is some reason to believe that MIT has been reasonably successful in undertaking this program. "A great deal of informal interaction exists between the program staff and industrial members ... and a high degree of satisfaction with the program is indicated by member firms". Despite this enthusiasm, at this point, it is by no means clear that federal contributions to the MIT projects do not simply substitute for funds the companies would have spent on research anyway, albeit in their own laboratories and not at MIT. Nevertheless, the MIT program represents a positive effort to use federal funds to reorient university research toward industrial interests, and it is worthwhile to summarize the major reasons for its present success.

(i) Before the program was instituted there was already some significant institutional or personal contact in existence. All companies who did join mentioned some form of previous connection. Most of the companies for example, were associated with MIT's industrial liaison program and had at least one MIT graduate among the two or three people who made the decision to join.

(ii) The establishment of a program organization which encourages and promotes interaction between the program staff, students, and industrial members. For example, a primary structural mechanism is the Industrial Advisory Committee. This group meets four times a year. In addition to developing rules on such commercial matters as patents and licensing, it provides a forum for an exchange of informal views and a mechanism for open and honest discussion. As a result, this rather unusual working group has developed considerable trust and ease of interaction. As well, students are given exposure to the whole R&D process (through the Bimonthly Meetings) which increases their perspective and prepares them for industry employment

(iii) The entrepreneurial, innovative and administrative abilities of the program director have been crucial since the initiation of the experiment. For example, one of the industrial members said that while they were considering joining they received problem-solving help from the director which provided a concrete example of what might be expected.

(iv) The existence of an established industrial base where a few large firms control the industry market has been an unexpected but necessary criterion. This factor has also been cited as a major reason for success of the CRCE program at Carnegie-Mellon (few companies with annual sales below $100 million participated). In contrast, the program at North Carolina State is directed toward the U.S. furniture industry, which is highly fragmented. Thus far, little success has been achieved mainly because of the managerial difficulties in getting many firms (who are supposed to be competing) to work together on common research needs. Furthermore, establishing effective links has been more difficult in this case because of the companies' limited R&D capability.

It should be noted that NSF has considered establishing regional research centres, under the Cooperative Research Centre's Experiment. This program would be quite similar to Canada's Industrial Research Institute Program (IT&C). Plans have been delayed, since as yet NSF has received little assurance that a regional institute could become self-supporting. Based on the North Carolina State experience, they want to make sure that the industries in a particular region have a solid economic base to continue to support a centre when the program terminates. As yet they have been unable to pinpoint a region that has this crucial characteristic.

III. OTHER COUNTRIES

In this section, only a brief summary of some of the mechanisms for technology transfer will be provided. Although detailed supportive documentation has yet to be obtained a recent review by OECD provides these highlights.

a) France

Although several mechanisms for industry/university technology transfer exist in France, only two of major importance are noted here. First, the government encourages university and industry to submit joint proposals for research support by paying fifty percent of the industrial share of the project and one hundred percent of the university share. Second, when a majority of firms in a sector insist, the government will mandate the creation of an industrial centre and a para fiscal tax is placed on all firms to support this centre. For example, the French centre for the study of plastic materials, which is similar to the MIT Polymer Processing Program of the United States, had a budget in 1972 of three million francs and employed forty-two people, including fifteen professionals. Although formally separate facilities are located at the Ecole National Superieure des Arts-et-Métiers (ENSAM), the director of this program is a professor and three faculty members are active participants.

b) Great Britain

Many mechanisms for university/industry technology transfer exist in Britain. For example, numerous British universities have a formal policy to promote industrial consultation by staff members. The industrial liaison officers at some universities and many technology institutes, with the help of the Department of Trade and Industry (formerly the Ministry of Technology) have the function of promoting industry/university links in every possible way. Other types of liaison exist at many universities. For example, the industrial innovation centre at Strathclyde University carries out work for industry and keeps in continuous contact with 650 staff members in order to direct industry to the right scientists. This centre, being relatively new, has not as yet achieved full success.

Not unlike Canada, Great Britain has a policy to support research associations. Although this provides a potential for stimulating university/industry technology transfer the extent of this interchange is limited since the associations are not located at the universities

c) Germany

The tradition here, of appointing industrial scientists to university posts, would appear to be one of the main reasons why German universities are more industry oriented than either

the French or British. These appointments form the bridge for technology transfer from university to industry by allowing these teachers direct contact with students thus enabling them to help industry find the right graduates. A secondary, but important, offshoot of this integrated approach is the fact that all chemistry teachers receive, at regular intervals, a sum of money from a fund financed by the chemical industry which they are expected to spend on research.

Another mechanism for stimulating industry/university technology transfer is known as the "teachersparty", whereby all newly appointed chemistry teachers are invited to industrial headquarters for a period, extending from three to four weeks. Here they are entertained, informed of company research being carried out and queried about their past and future plans. Other industries use similar mechanisms but not to the same extent as the chemical industry. The importance of this interaction should not be underestimated since this has proved to be a key mechanism responsible for the success of MIT's Polymer Processing Program.

d) Sweden, Switzerland, Norway and the Netherlands

The major thrust in Holland is the encouragement of industrial scientists to teach at the universities. This direct approach was developed in Holland but exists also in Germany, Belgium, Switzerland and Sweden.

Dutch senior researchers from every large industrial laboratory and many small companies spend approximately fifteen percent of their working time teaching at the university. This is done in full agreement with their companies who know that it is to the ultimate interest of industry to contribute to the universities. This institutional flexibility in higher education is rare elsewhere and is a modern expression of an old tradition for survival. Today one quarter of all Dutch university professors in science and technology are active industrial researchers, having found this to be one of the most important mechanisms for stimulating technology transfer.

Research in the technical universities of these small countries seems to have played a major role in increasing university/industry links. Unlike the elite schools in France and Britain (for example, the Ecole Polytechnique in Paris and Imperial College in London) these technical universities are geared to industrial research needs. Here there is close association between industrial research institutes and technical universities as the bulk of research in these universities is of direct interest to national industry. As a result, the universities train students for industry not only through their

curriculum but also by giving them industrial attitudes and motivations. This concentration on industrial research needs is reflected in the policy of institutes which require new students to work approximately six months in industry prior to enrollment. Also, for teaching appointments, industrial experience is a definite asset and in some cases even a requirement.

Some institutional mechanisms created by governments of these countries toward support of industrial research are:

1- NETHERLANDS-TNO (Central Organization for applied research);

2- NORWAY-NTNF (Norwegian Council for scientific and industrial research; and

3- SWEDEN-STU (Swedish Board for Technical Development)

These government institutes are major clearing houses of industry and university knowledge and are important links for technology transfer. In all countries, these bodies which draw both sides together prove to be a very valuable mechanism for university/industry links.

IV. SUMMARY

The introduction of mechanisms and programs to stimulate technology transfer have been partially successful in Canada. On a positive note, IT&C has developed two innovative programs which are intended, in part, to stimulate technology transfer from the universities to industry. The Industrial Research Institute Program is designed to provide research facilities, on a self-supporting basis, to service the various industrial needs of a particular geographic region. To this extent, the IT&C experiment has been quite encouraging. For example, nine industrial institutes are now staffed and operating, five of which are self-supporting. The other four are expected to become self-supporting within the next three years.

The Centres of Advanced Technology Program of IT&C has also shown healthy signs of success. Nine centres of advanced technology have been established, five for which IT&C grants have terminated and now operate on a self-supporting basis.

What is unknown about these IT&C programs is the extent to which university/industry technology transfer has occurred and the related benefits. For example, the available documentation has not allowed the investigators to determine the number of new jobs created, the number of students who found meaningful employment or the net tax revenue resulting from the creation of new ventures.

The Industrial Research Association Program of IT&C was introduced to encourage industrial sectors to aid in support of establishing and maintaining R&D facilities dealing with technological activities common to a specific industry. Thus far the program has been reasonably successful; three associations have been formed and are well on their way to becoming self-supporting. However, in contrast to the Industrial Research Institute Program, the Centres of Advanced Technology of IT&C and the Cooperative Centres Experiment of the National Science Foundation, these Associations are not located at universities and this has limited the extent of university/industry technology transfer.

The Innovation Centres Experiment of the NSF which has no Canadian counterpart transcends the typical mold of the university. Each centre has as a common objective the demonstration that university-based activities can stimulate innovation and entrepreneurship in the external business community. This program has had outstanding interim results. For example, these centres have contributed to the creation of over 30 new ventures, of which 23 have achieved sales in excess of $30 million, (1975-76) resulted in approximately 1,000 new jobs and generated in excess of $6 million in tax revenue.

The present NRC programs for stimulating technology transfer from the university sector to industry; Project Research Applicable in Industry (PRAI) and Industrial Post-Doctoral Fellowships (IPDF), have not been encouraging despite NRC's efforts. The PRAI grants are designed to support those whose research has already led to the identification of a specific and novel technique, process or product promising to be of commercial value to Canadian Industry. This program has suffered from a lack of participation on the part of university faculty. It is the authors' view that this situation has occured because there are no mechanisms to support the innovator or entrepreneur during the development stage. In most cases, considerable effort must be devoted to the new product or idea before it displays a promising commercial value. Potential inventors have not had the necessary environment, support or complimentary expertise to properly develop a concept to the extent that it will be appealing to industry.

The Industrial Post-Doctoral Fellowships (IPDF) program of NRC is designed to encourage students who have recently received, or who are about to receive, their doctoral degree to seek careers with Canadian industry. This program has also suffered from a lack of participation. For example, the number of IPDF's totalled only 125 awards in 1976-77. In the

view of the investigators, this has occurred because students have had little opportunity to work with industry prior to graduation. This situation can be corrected. If mechanisms are developed to encourage student researchers to work with industry; by graduation they will be in demand on the job market as evidenced by the experience of many European Countries and MIT's Polymer Processing experiment.

With respect to France, Great Britain, Germany, Holland, Sweden, Switzerland, Norway and the Netherlands, governments in all these countries, in varying degrees, sponsor programs linking industry with university. The programs and mechanisms are particularly successful in Germany, and the Scandanavian countries. Direct university/industry linkages are a tradition in these countries and need little encouragement from the government sector. Industries encourage their researchers to teach at the university, new students in some countries are required to work in industry even before entering university and some teaching appointments are conditional upon industrial experience.

These countries seem to have created a climate conducive to innovation based on the spontaneous initiative of groups and

individuals. The results of these efforts are indeed encouraging. Productivity output/manhour of many of these countries has outstripped the United States over the last ten years. Success seems to breed success. Many countries, for example, still feel that univeristy teaching by industrial scientists adds more industrial relevance to university teaching and that industry should be given an even stronger official voice in science curriculum.

PROGRAMS OF INDUSTRY, TRADE AND COMMERCE TO STIMULATE TECHNOLOGY TRANSFER FROM THE UNIVERSITIES TO INDUSTRY

The Industrial Research Institute Program Grants

University	Grant and Term	Termination date
Nova Scotia Tech.	$270,000 - 7 years	March 31, 1974
Windsor	$236,895 - 7 years	June 30, 1974
McMaster	$358,000 - 7 years	Sept. 30, 1974
Waterloo	$244,557 - 6 years	Nov. 30, 1973
McGill	$204,000 - 4 years	Aug. 15, 1975
Ecole polytechnique	$260,000 - 5 years	Sept. 30, 1976
Ryerson	$150,000 - 5 years	July 31, 1977
Universite du Quebec a Montreal	$180,000 - 3 years	May 31, 1976
University of Manitoba	$165,000 - 3 years	Sept. 30, 1976
Guelph*	$150,000 - 3 years	March 31, 1976

* This grant was terminated July 31, 1974 after payment of $65,383 and operation of the Food Industry Research Institute was discontinued.

Source - Dept. of Industry, Trade & Commerce, Office of Science and Technology "The Industrial Research Institute Program, The Centres of Advanced Technology Program, The Industrial Research Association Program", Annual Report 1975/76, Ottawa, December 1976.

The Centres of Advanced Technology Program

Grants

Name of Centre and Parent Institution	Grant, Term & Termination date
Centre for Powder Metallurgy (Ontario Research Foundation)	$450,000; 3 years; June 30/74
Systems Building Centre (University of Toronto)	$300,000; 3 years; Sep. 30/74
Canadian Institute of Metalworking (McMaster University)	$830,000; 6 years; Sep. 30/76
Centre for Ocean Engineering (B.C. Research)	$1,225,000; 3 years; Mar. 14/76
Centre for Ocean Technology (Nova Scotia Research Foundation)	$875,000; 5 years; May 31/79
Systems Analysis, Control and Design Activity (University of Western Ontario)	$525,000; 3 years; Oct. 31/76
Centre de technologie de l'environnement (Universite de Sherbrooke)	$300,000; 3 years; Oct. 31/77
Canadian Food Products Development Centre (Manitoba Research Council)	$1,000,000; 5 years; Mar. 31/79
Biomedical Instrumentation Development Unit (University of Toronto)	$875,000; 5 years; Feb. 28/81

Source - Dept. of Industry, Trade & Commerce, Office of Science and Technology "The Industrial Research Institute Program, The Centres of Advanced Technology Program, The Industrial Research Association Program", Annual Report 1975/76, Ottawa, December 1976.

The Industrial Research Association Program

Association	Amount	Termination Date
Sulphor Development Institute of Canada	$ 1,400,000	June 30/76
Canadian Welding Development Institute	$ 875,000	July 31/78
Canadian Gas Research Institute	$ 875,000	Dec. 31/79

Source - Dept. of Industry, Trade & Commerce, Office of Science and Technology "The Industrial Research Institute Program, The Centres of Advanced Technology Program, The Industrial Research Association Program", Annual Report 1975/76, Ottawa, December 1976.

APPENDIX II

OTHER CANADIAN PROGRAMS THAT INDIRECTLY STIMULATE TECHNOLOGY TRANSFER

Industrial Research Association Program (IT&C). This program was introduced to encourage industrial sectors to aid in support of establishing and maintaining R&D facilities dealing with technological activities common to industry. To date, their have been three associations, two of which are still being funded (see Appendix I). Assistance for this program is similar to that of the Centres of Advanced Technology Program.

Enterprise Development Program (IT&C) 1977. Several of the Development incentive programs of the Department of Industry, Trade and Commerce (PAIT, PEP and IDAP) are being consolidated into this program. The program will provide financial support for product development, studies for pre-production design and engineering productivity and determining market feasibility and strategies. The program will cover up to 50 percent of eligible costs of specific innovation projects and assist firms when the project appears commercially viable and represents a significant burden on the firm's resources.

Defence Industry Productivity (IT&C) 1968. This program is the combination of the former Industry Modernization for Defence Exports Program and the Defence Development Sharing Program. Its purpose is to sustain the technological capability of the Canadian Defence Industry. The grant includes cost-sharing of up to 50 percent of current and capital R&D expenditures for defence-oriented R&D.

Pilot Industry-Laboratory Program (IT&C) 1975. This program is aimed at accelerating the pace of transfer of technology into industry by contracting-out parts of NRC's research programs.

Industrial Research Assistance Program (NRC) 1962. This program is designed to encourage long-term applied research. Under this program, grants of up to 50 percent of salaries and wages for R&D staff and of the cost of certain fixed assets are available to all companies incorporated in Canada. The grants reduce both current R&D expenditures and the capital cost of fixed assets for income tax purposes. A group of companies may combine to select a project of mutual interest.

Cooperative Pollution Abatement Research Program. This is a government-industry cooperative program aimed to produce development standards for effluent control in the Canadian Pulp and Paper industry. Its intent is also to develop cheaper and more effective methods of dealing with water and air pollution control in this industry.

Industrial Energy Conservation Research and Development Program 1977. This program provides assistance for R&D aimed at new energy-conserving technology.

Program to Stimulate the Development and Demonstration of Pollution Abatement Technology (Environment Canada) 1975. This program is designed to stimulate the development and demonstration of new technology for the abatement of pollution in Canada. The level of cost-sharing by the government is negotiable. DPAT contracts require that any technology developed under this grant be made freely available to any other Canadian business.

OTHER UNITED STATES PROGRAMS TO STIMULATE TECHNOLOGY TRANSFER

(1) MECHANISM	EXAMPLES	COMMENTS
Direct corporate funding of University Research Projects	i) Harvard/Monsanto Biological and medical research program (1975)	This arrangement represents a long-term (12 years) high level committment ($23 million) to support basic research. It is hoped that it will result in improved interactions that favour technology transfer. However it is too soon to judge on the relative success.
(2) Cooperative Research Programs	Presently NSF sponsors cooperative research programs at Carnegie-Mellon, North Carolina State University and MIT	This program is designed to stimulate technology transfer for specific industries. It has been most successful in large industries where a few firms control the market.
(3) University/ Industry Research Consortia	i) Department of Defence in the development of military technology ii) Clemson University experiment/Dept. of Commerce research on fabric flammability iii) Gulf Universities Research Consortium	A group of experts in the field defines the key research needs, selects proposals from both university and industry. The consortia are most productive when they are directed toward the achievement of a specific goal. As yet, it is too soon to comment on the relative success in stimulating technology transfer.
(4) Joint Industry/ University Laboratory	Fluid Dynamics and Energetics Laboratory of New York	Because of the basic differences between universities and for-profit organizations it has been extremely difficult to promote this type of activity.

(5)	Technology Licensing and Technological Brokers	New England Energy Development System (NEEDS) developed by MITRE Corporation funded by NSF (a component of NSF's Cooperative Research Program	An organization is established to coordinate university research with the needs of industry. In the case of the MITRE experiment, an attempt was made to "facilitate the flow of technology between the New England electric utilities and those universities/non-profit research groups capable of performing research needed by the utilities". Again, it is too early to evaluate the relative success of this mechanism.
(6)	Extension Services	Energy Advisory Service for Texas (EAST) organized by Texas A&M University	The University develops an extension centre designed to provide contacts and expertise on particular issues. In general, this approach appears to be most appropriate for fragmented industries where the cost of obtaining information about new developments is high.
(7)	University Industrial Associates	Successful Industrial Associates programs are operating at MIT, Stanford and California Institute of Technology.	Member companies contribute an annual fee between $15,000 and $25,000. In return, they exchange research results in fields they are actively pursuing and receive intensive briefings in unfamiliar areas. Only a few of the nations most prestigious institutions have been able to achieve the appropriate number of corporate members needed to defray costs of running the program.

(8)	Industrial Parks near universities	i) Stanford Industrial Park ii) Research Triangle Park (University of North Carolina)	Since this requires strong political and financial commitments by universities and governments only a limited number of universities have been successful.
(9)	Innovation Centres Experiment	Presently there are three innovation centres supported by NSF at the University of Oregon, MIT and Carnegie-Mellon University.	The program is designed to provide support for inventors and teach the necessary skills to move a new product from the laboratory to the market place. At present, it is too soon to evaluate the overall success of this program but preliminary evidence appears encouraging.
(10)	University Business Development Centres	University Business Development Centres (UBDC's) established by the Small Business Administration.	These programs have had little direct effect on university research links with industry since the institutions carry out little on-going research. However, they may stimulate technology transfer indirectly by helping establish new firms that may then acquire technology from universities.

V. SELECTED REFERENCES

Allen, J., ed. Guide to World Science. Volume 2 France. Francis Hodgson (F.H. Books Ltd.,), Guernsey, British Isles, second edition, May 1975.

Bourgault, Pierre L. Innovation and the Structure of Canadian Industry. Background Study for the Science Council of Canada, Special Study No. 25, Information Canada, Ottawa, 1972.

Bumstead, D.C., R.T. Lord, M.A. Sirbo. The MIT - Industry Polymer Processing Program: An Experiment in Process. Centre for Policy Alternatives, Massachusetts Institute of Technology, Massachusetts 02139, June 30, 1976.

Burger, R.M. Rann Utilization Experience. Innovation Centres, Case Study No. 33, Research Triangle Institute, Research Triangle Park, North Carolina.

Canada, National Research Council. Selected Annual Reports on Scholarships and Grants in Aid of Research. Ottawa.

Canada, Office of Grants and Scholarships. PRAI Grants. National Research Council, Ottawa, September 1973.

Canada, Science Council Committee on Industrial Policies. Uncertain Prospects, Canadian Manufacturing Industry 1971-77. Science Council of Canada, Ottawa, October 1977.

Canada, Office of Science and Technology. The Industrial Research Institute Program, The Centers of Advanced Technology Program, The Industrial Research Association Program. Annual Report 1975-76. Department of Industry Trade and Commerce, Ottawa, December 1976.

Caty, G., G. Drilhon, G. Ferré, S. Wald. The Research System. Comparative Survey of the Organization and Financing of Fundamental Research. Volumes 1,2,3. OECD, Paris, France, 1972.

Forbes, D.B., ed. Guide to World Science. Volume 3 The Netherlands. Francis Hodgson (F.H. Books Ltd.), Guernsey, British Isles, second edition, July 1975.

Harvey, A.P. ed. Guide to World Science. Volume 1 United Kingdom and Republic of Ireland. Francis Hodgson (F.H. Books Ltd.), Guernsey, British Isles, second edition, October 1974.

Holmes, E.W., F.V. Maltby, K.D. Srivastava. Contract Research as a Mechanism for Increasing the Turnover of Research Personnel. University of Waterloo, Waterloo, Ontario.

Peitchinis, S.C. Effect of Technological Changes on Educational and Skill Requirements of Industry. Department of Economics, University of Calgary, Calgary, Alberta, November 1977.

Quebec, Office of Industrial Research. Annual Report for 12 months ending August 31, 1974. McGill University, Montreal, Que.

Salendar, C. ed. Guide to World Science. Volume 3 Germany. Francis Hodgson (F.H. Books Ltd.), Guernsey, British Isles, second edition, December 1974.

Smith, B.L.R., J.J. Karkesky. The State of Academic Science. Change Magazine Press, New Rochelle, N.Y., 1977.

U.S.A. An Analysis of the National Science Foundation's Innovation Centers Experiment. Research Triangle Institute, Research Triangle Park, North Carolina, July 1977.

Waterloo, Office of Research Administration. Report for 1976-77 Year. University of Waterloo, August 1977.

West, A.S. National Engineering, Scientific and Technological Societies of Canada. Background Study for the Science Council of Canada, Special Study No. 25. Information Canada, Ottawa, 1972.

Windsor. Report on the Institute's First Five Years. Industrial Research Institute, University of Windsor. September 1972.