Industry, Science and Technology Canada
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The "Whole Enterprise" Strategy for the Acquisition and Diffusion of Technology in Canada

Canada

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Final Report
to the Departmental Management Committee of Industry, Science and Technology Canada by the
Task Force on Technology Diffusion Strategy

This report is an internal working document of Industry, Science and Technology Canada and its collaborators -- The National Research Council, External Affairs and International Trade Canada, and Investment Canada. It should not be construed as representing the policy of any of these organizations or of the Government of Canada.

ISTC
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THE STRATEGY IN BRIEF:

Summary and Recommendations

This report outlines a proposed strategy for ISTC and its various partners in the delivery of policies, services and programs relating to the acquisition and diffusion of technology. The report has been prepared by a Task Force consisting of officials, primarily at the level of Director, from ISTC, the National Research Council, External Affairs and International Trade Canada, and Investment Canada. Other public, private and academic sector organizations have been consulted in the preparation of this report.

The report was commissioned by the Policy Management Committee of ISTC in April 1991, in an attempt to provide an overall framework and set of priorities for the activities, principally but not exclusively, of ISTC in supporting technology diffusion, as the uptake of best-practice technology by Canadian firms was perceived to be a serious shortcoming in Canadian economic performance.

The report represents the consensus of the Task Force members. It should not be construed as representing the official position of ISTC or any of the other participating organizations.

Scope and Definitions

Technology is an investment issue. This report focuses on factors affecting the **technology investment decisions** of **small and medium-sized enterprises** throughout Canada. This is a **demand-side** analysis, conducted from the point of view of the individual firm.

A broad definition of *technology* as knowledge and know-how, embodied in various forms, has been adopted. The level of technology considered is referred to generically as *best practice*, that which offers the firm a competitive advantage; the precise meaning will vary according to the firm and the industry. *Technology diffusion* refers to the processes and mechanisms by which companies source, acquire, adopt adapt and manage technology. This includes management attitudes, capabilities and processes.

The Challenge

Small and medium-sized enterprises are fundamental contributors to economic growth, and their role, particularly in relation to the commercial application of technology, is being increasingly recognized in industrialized countries. Yet, there is growing concern that SMEs find it difficult to make

use of technology; thus the ability to generate technology is outstripping the ability to put it to commercial use.

The problem appears to be particularly acute in Canada, where firms lag their counterparts in the United States in using advanced manufacturing technologies.

A Framework for the Strategy

A growing body of economic and business literature, including extensive interviews with eighty firms conducted by ISTC, identifies several key factors affecting technology investment decisions. These are:

- attitudes and orientation of management and labour;
- management capabilities and processes;
- available skills base;
- availability and cost of financing;
- regulations and standards;
- linkages between receptors and sources of technology; and

This framework of factors has guided the work of the Task Force.

The Role of Government

Governments within the OECD increasingly recognize the important role of government in creating the conditions for rapid and effective technology diffusion, i.e., a "diffusion-oriented" economy. The role of government takes different forms. There is a general trend towards:

- strengthening of technology diffusion infrastructure as opposed to large technology development projects and programs;
- the use of technology extension networks that deal with various aspects of technology in the business; and
- better integration and coherence in policies and in service and program delivery.

In Canada, the federal and provincial governments have a host of activities in the area of technology diffusion and these are growing in number and scope, particularly in the provinces. The main gaps are in management attitudes and practices, even though this is increasingly recognized as critical to technology demand and investment success.

In the light of the available evidence, the Task Force has concluded that the role of government lies in four general areas:

- **"mind-set"** (knowledge, attitudes, orientation of management and labour)
- **"skill set"** -- managerial, professional, technical, trades
- **business (investment) environment**
- supporting **infrastructure**.

Governments, like companies, must be able to deal with technological capability in the context of the strategy for the **business as a whole.**

The "Whole Enterprise" Strategy

Principles

The Task Force adopted the following principles to guide the activities of ISTC in working with its partners.

- Activities should be aimed at helping firms to help themselves, with a focus on services as opposed to financial assistance.
- Government should ensure that services are provided, not necessarily provide them directly.
- At the level of this strategy, no firms are to be excluded from consideration, i.e., any targeting will be determined by service providers in response to market.
- Government departments and agencies should cooperate in assisting clients, and should not compete for clients.

Objectives

1. Overriding Objective: **To promote the competitiveness of SMEs by building the capability, within companies and government organizations, to deal with technology investments in the context of the whole enterprise.**

2. To bring about changes in attitudes and orientation among management and labour in Canada such as to create a diffusion-oriented culture or **mind-set**, and to promote and favour investments in technology, in order to improve the receptor capabilities of users of technology.

3. To help to build the **skill set** within and available to companies.

4. To increase the availability to companies of information, intelligence, expertise and advice that they are not able to develop internally.

5. To establish a **business environment** that is conducive to long-term investments in technology.

6. To foster an integrated, cooperative approach to policies, programs and services across the federal government in cooperation with the provinces.

7. To promote national unity through:

   - national service networking and **infrastructure** development for mutual interregional support; and

   - federal-provincial cooperation in networking and service delivery.

Elements of the Strategy

Policies Affecting the Business Environment. These are many and varied, ranging from competition through trade to taxation and regulations. They are the most important measures governments take that influence technology investments. Greater coherence in the various policies as they affect such investments is needed. The Task Force proposes special attention to financing, standards and regulations. Our knowledge base on the influence of standards and regulations on technology diffusion needs to be expanded.

Management. Management attitudes and capabilities underlie the demand for and the successful acquisition and use of technology. Management

excellence should be the cornerstone of technology diffusion policy, and the main area of emphasis in the development and provision of new services and programs. Management services need to be linked to technology services in a whole enterprise approach. Management training needs to reach out to SMEs more effectively.

Human Resources. The role of ISTC in this area needs to be clarified. Like management, skills are fundamental to the technology diffusion process. A full partnership with CEIC, and at both the strategy and delivery levels, is essential. Supply and demand analysis and the promotion of S&T careers should be maintained and strengthened.

Technology. While the availability of technical information and technology itself is not the main shortcoming in Canada, there are some gaps, for example in the provision of technological intelligence and assessments and evaluation of technology. The technology infrastructure is reasonably strong but needs to be better coordinated and tied to other business needs.

At the international level there are issues of access and information, and the formation of relationships with foreign sources of technology. Trade policy is important in relation to access. The main instruments of the federal government in international technology acquisition are the Technology Inflow Program and the network of technology development officers at the posts. Both need to be enhanced. In addition, technology acquisition can be featured in bilateral and multilateral S&T strategies and agreements, as is proposed for the Europe S&T strategy.

The Role of Science-Based Departments and Agencies. Government laboratories are increasingly recognizing their role in supporting the technology capabilities of SMEs and have taken some steps in this direction, including action on alliances, a "road-map" to S&T capability and a "tool-box" for providing more complete service to firms. These actions are consistent with the recommendations of the Task Force and SBDAs need to be considered full partners in the national diffusion system.

The Role of Colleges and Universities. Some academic institutions are actively involved in technology transfer and other forms of support, but in general they lack a demand-side perspective. The programs of NSERC could be strengthened in order to fortify the industry/university linkages. Universities and colleges with significant technological capabilities also need to be considered full partners in the system.

The Delivery Infrastructure: A National Industrial Technology Extension System

The Task Force recommends that steps be taken to establish a national extension system to deliver the Whole Enterprise approach to SMEs in all parts of Canada. The system should be built on existing networks and institutions, at the national, regional or provincial level. To facilitate access to technology, expertise and assistance tools, the regional networks should be tied together nationally and linked to international sources.

Within each region, public, private and academic sector organizations that deliver technology related services directly to firms should cooperate in offering a full-service package, starting with a simple diagnosis and pathfinding service in order to ensure that firms' specific needs are met. Full electronic connection of the various nodes would be desirable and essential, and could be developed over time. A major goal would be to reduce the need for firms to shop around for assistance.

Two options were explored by the Task Force. One would involve training existing officers in the various organizations on diagnosis, problem-solving and the features of the array of policies, programs and services available throughout the network, in order that each node could offer a relatively complete service and minimize the number of stops for firms. The second option envisions the creation of regional business counsellors and generalist mentors (some of which already exist), to analyze the specific needs of companies and point them to experts to ensure that they find the kind of support they need.

Outstanding Issues and Research Needs

While the evidence is compelling that Canadian firms need to upgrade their technological capability, there remain shortcomings in the data and other forms of quantitative information on the technological performance and capacity of firms and of the economy as a whole. In addition, there is a need for better information on the important role of standards and regulations in the diffusion of technology.

Implementation Plan

The next step in implementation of this strategy is to seek policy approval for the overall thrust by establishing linkages with the Prosperity Initiative. (The work of the Task Force is already linked to -- indeed, has influenced -- the Portfolio Directions discussions.)

It is important at this stage that Portfolio organizations and other partners in technology diffusion become full participants in implementation. The recommended steps include:

- establishment of a task team of Assistant Deputy Ministers or equivalent from Portfolio organizations to oversee the production of "umbrella" recommendations to Cabinet before the summer of 1992;
- development of companion or follow-up MCs or Treasury Board submissions on specific initiatives;
- establishment of partnerships with other stakeholders at the national and regional levels, e.g., SBDAs, provincial governments;
- organization of workshops in each region (or where appropriate) to accelerate and enhance the extension system-building process;
- launching of major studies on standards and regulations and electronic networking.

Summary of Recommendations

The Task Force offers recommendations across the spectrum of technology diffusion activities. The principal recommendations are as follows:

Recommendation 1. That these objectives be adopted as the foundation for a strategy on technology diffusion in Canada.

Recommendation 2. That the federal government continue to strive toward coherence in its various policy actions, following the principles outlined in the OECD TEP process.

Recommendation 3. That tax incentives for SMEs acquiring technologies be supported and sustained.

Recommendation 4. That efforts to increase understanding between SMEs and suppliers of finance be supported and endorsed.

Recommendation 5. That a major study be undertaken of the impact of standards and regulations on the diffusion of technology.

Recommendation 6. That excellence in management be made a fundamental element of the technology diffusion strategy. This

should include leading by example, e.g., through the attitudes and skills that the federal public service demands of its executives.

Recommendation 7. That the use of Advanced Manufacturing Technologies Applications Program as it currently exists be expanded, that an AMTAP implementation element be established, that the use of Manufacturing Assessment Service as a general diagnostic tool be expanded.

Recommendation 8. That the use of international benchmarking as a means of assisting firms to gauge their performance and competitiveness be expanded.

Recommendation 9. That the government should also continue to investigate and develop ways and means of providing programs and services which help to change the mind-set and build up the skills of managers.

Recommendation 10. That ISTC continue to support the development of activities leading to the identification of the nation's human technical resources including specialists, scientists, engineers and technologists. ISTC should encourage the development of policies, procedures and agreements whereby scientific and engineering personnel supported by federal moneys are expected to offer technical expertise to industries in return for that support.

Recommendation 11. That federal and provincial agencies continue to develop the kind of awareness/education initiatives they have been developing throughout the country. These services, both federal and provincial, are generally aimed at encouraging young people to consider careers in science/engineering/mathematics and teaching careers in these disciplines.

Recommendation 12. That ISTC should examine the possibilities of establishing closer partnership arrangements with NRC/IRAP and Employment and Immigration Canada leading to the creation of more skill-building activities for young men and women.

Recommendation 13. That holistic approaches should be taken to resolving the difficulties that firms have in acquiring and deploying appropriate technologies. In particular, there is a need to collaborate and cooperate more fully between existing technological and business-support programs and services.

Recommendation 14. That the Industrial Research Assistance Program (IRAP) of NRC should be clearly recognized as the dominant industrial technological support and enhancement system and network in the nation and should be sustained, strengthened and adequately funded.

Recommendation 15. That the TOP program should be enhanced and further promoted, and continue to be linked effectively with the IRAP technology network.

Recommendation 16. That ISTC and IRAP networks should jointly explore the possibilities of establishing a national technology clearing house for Canada so that both domestic and foreign technologies could be examined and banked for use upon demand by agencies, industry support organizations and firms requiring them.

Recommendation 17. That scientific and technological intelligence gathering and dissemination should become an integral part of the work of the Strategy. This could be accomplished in part by scientists and engineers in agencies throughout Canada as a formal part of their mission in attending scientific and technological conferences and workshops world-wide.

Recommendation 18. That efforts to increase the access to and utilization of patent information should be encouraged and supported.

Recommendation 19. A plan should be developed to establish an institution, preferably within the private sector, with joint public/private support, to carry out technology assessments on an on-going basis, in critical areas of science and technology.

Recommendation 20. That international technology acquisition activities should be an integral component of a nation-wide domestic industrial support network and international technology acquisition activities throughout Canada should be promoted, developed and supported.

Recommendation 21. That the Technology Inflow Program should be re-instated at an increased level of funding and the offshore Technology Development Officer network should be maintained and increased. Industry should be encouraged to engage more fully in international technology acquisition and ways should be sought to

increase the number of private sector organizations involved in the activities.

Recommendation 22. That the technology transfer endeavours of the SBDAs continue to be supported and that partnerships be strengthened between SBDAs and other organizations and networks in Canada that provide technology-related services to SMEs.

Recommendation 23. That ISTC should continue to work with the SBDAs to develop an appropriate and common "toolkit" aimed at increasing the SBDAs' supporting relationships with SMEs. This should be integrated with or complement, existing "toolkits" supporting technological development in SMEs.

Recommendation 24. That the mobilization of the intellectual capital resources of the more pragmatically-orientated departments within universities, such as Faculties of Engineering and Architecture, and/or the specialized departments such as Food Processing Sciences or Fisheries Technologies should be considered as a priority for action in Canada. Efforts should be made to ensure that Universities and Colleges throughout Canada become active nodes in a national industrial extension network incorporating both technological and business support. University departments such as Engineering should be specifically targetted for inclusion in the national IRAP network. This should be carried out incrementally over a short number of years.

Recommendation 25. That a national industrial technology extension system be established to reach out to firms all across Canada by building on what is in place, capitalizing on positive initiatives, and linking institutions and services together to form a coherent package.

Recommendation 26. That the system be built initially at the local and regional levels, as close to the customer as possible, including private sector service providers, and workshops be held in each province or region as appropriate within the next six to eight months to begin the building process.

Recommendation 27. That a feasibility analysis be undertaken of the establishment of the single system at the national level and of the direct linkages to posts abroad. This would include an analysis of the feasibility and costs of creating full electronic interconnection beginning with existing electronic networks and data bases.

Recommendation 28. That consultations with the provinces begin at the provincial level on ways to integrate federal and provincial activities into a mutual support system.

Recommendation 29. That support be given towards the development of service industries (e.g., consultants, training organizations) as key agents in the "close to the customer" delivery approach.

Recommendation 30. That options for managing and structuring the elements of the system be examined in order to promote a full commitment to the business client and integrate the planning, strategy and delivery operations of participating organizations more fully.

Recommendation 31. That research projects be designed and carriewd out to expand intelligence on methods of increasing utilization of technology by firms, recognizing that there are gaps in the current information on technology diffusion mechanisms.

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5. OBJECTIVES OF THE STRATEGY

6. ELEMENTS OF THE STRATEGY

1. SCOPE AND DEFINITIONS

1.1 Demand-driven

This report is about the **demand** for technology by individual firms. In a market economy, technological capability is built by the strategic decisions of private and public sector organizations -- investment decisions relating to the role of technology in the organization. The company's technology investment portfolio can include R&D as well as acquisition, adoption and adaptation. It is not a simple "either-or" or "make-or-buy" decision.

1.2 Acquisition of technology

Nonetheless, this report is not about technology development or R&D *per se*, but rather about the **acquisition of technology** that has been fully or primarily developed by other organizations and is adopted or adapted by the acquiring firm. Some R&D may be performed in the adaptation process. As the next chapter points out, R&D performance information can be a useful proxy for measuring technology acquisition performance.

1.3 Technology

In this report, the term *technology* is used in a very broad sense. A useful definition is provided by the World Intellectual Property Organization:

> *Systematic knowledge for the manufacture of a product, the application of a process, or the rendering of a service, whether that knowledge be reflected in an invention, an industrial design, a utility model, or a new plant variety, or in technical information or skills, or in the services and assistance provided by experts for the design, installation operation or maintenance of an industrial plant, or for the management of an industrial or commercial enterprise or its activities.*

It should be noted that the definition encompasses management capabilities, skills and techniques. It also deals with technology applied to processes *and* that applied to products.

1.4 Technology diffusion

The term *technology diffusion* is a convenient but inadequate and poorly understood term that is used widely and loosely to refer to the process(es) by which scientific and technological knowledge and know-how are acquired and put to practical use in the economy. As used in this report, the term refers to the **processes and mechanisms by which companies *source, acquire, adopt,***

adapt and manage **technology**. Again, the focus is very much on the demand for technology and the actions of firms.

1.5 Small and medium-sized enterprises - SMEs

Companies or *firms* refers to **small and medium-sized enterprises (SMEs)** in all sectors and in all parts of Canada. These *receptors* for technology are the focus of this report. No strict definition of "small" or "medium" has been adopted. It should be noted that some units of large companies operate with a high degree of independence and therefore should be considered SMEs for purposes of this analysis.

1.6 Best practice

The level of technology considered in this report will be referred to generically as *best practice*. The choice of this term reflects the scope and the objectives of the strategy outlined herein. One of the goals of the strategy is to promote and encourage the continuous striving by firms to gain an advantage over competitors.

The meaning of *best practice* is a function of the technical sophistication, market position and internal capabilities of the firm, and of the industry of which it is a part. Thus *best practice* can for some firms refer to a technology that is emerging from a laboratory and has not yet been commercialized; for others it can refer to "off-the-shelf" technology. In interpreting this term, however, the objectives of the strategy should be kept in mind: namely, to do what is necessary to help Canada's firms develop a competitive edge.

2. THE CHALLENGE

2.1 Background to the problem

Canadians everywhere are gravely concerned about the ability of firms across Canada to successfully compete in today's global marketplace. Firms nation-wide face growing competitive pressure to modernize production, increase productivity, or create special product advantages through design, quality or product performance features. Many firms, particularly SMEs, find this increasingly difficult to do because of the rapid pace of change and the need for ever higher levels of technical sophistication. The difficulty is compounded by the nature of the new technologies; they demand profound changes in management, knowledge, skills, and attitudes. Job content must change and even suppliers and customers have to be persuaded to interact with companies in new ways.

2.2 The Issues as they particularly apply to SMEs

Studies in Europe over the past 15 years have repeatedly indicated difficulties are encountered by SMEs throughout the industrialized world in the application and use of technologies. As recently as November 1990 the OECD reported that the reasons why SMEs are behind in the utilization of new technologies were:

> *"....the failure of technology to meet their real needs, their poor knowledge and lack of skills, flimsy links with technological information networks, absent or deficient technological information networks for SMEs...."*

The report added:

> *"....the importance and quality of the information network are vital factors in fostering the dissemination and penetration of new technology, especially in small firms....for this reason, many governments have begun to support or develop effective technology transfer networks."*

In Canada over the past few years, agencies in both the federal and provincial governments working with the technical problems of SMEs throughout the country have repeatedly reported similar findings.

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From all of these reports then, it is clear that SMEs:

- find it difficult to identify their technical deficiencies or solve their technical problems within their organization;
- are, for the most part, unaware of technical information or technological alternatives which could be germane to their needs;
- have problems in identifying, locating and acquiring "best practise" technologies of either immediate or long term advantage to them;
- have few or no technically trained people on staff;
- may lack skills in strategic planning, marketing, exporting, and in the implementation and management of technology;
- may be unaware of, or reluctant to approach federal and provincial programs and agencies which could provide them with technical information and practical assistance.

Similar findings are to be seen in recent studies in the USA. Prof. C. Richard Hatch of the Centre for Manufacturing Systems at New Jersey Institute of Technology expresses this succinctly in his article on Manufacturing Networks:

> *"The overall competitiveness of American industry has come to rest squarely on the ability of existing small and medium-sized firms to meet the cost, quality, and delivery demands of major industrial customers. These smaller companies, which employ nearly two-thirds of the blue-collar labour force, now supply the bulk of the parts and components used in the production of finished goods for both domestic and export markets. The proliferation of SMEs and the downscaling of big ones are creating significant challenges for economic development officials. It is one thing to negotiate the location of a branch manufacturing plant employing several thousand workers; it is quite another to service thousands of smaller enterprises in hundreds of different industries, each with specific technologies and markets to be mastered. Yet, as firm size goes down, the need for such assistance goes up; the traditional limitations of small firms, (restricted access to capital, little or no R&D capability, lack of management depth and marketing savvy), are well known. The magnitude of the problem, the limited time remaining to reach competitive levels, and the shortage of public resources are driving home the need for new approaches."*

A National Governors' Association group examining the role of state and federal extension activities in 1990 noted that:

> *"To compete in world markets, U.S firms must continually adopt new technological processes and introduce new products. Yet indications are that U.S. manufacturers have been slow to automate and use existing technologies....Small and medium-sized businesses require assistance in adopting existing technology rather than access to advanced state-of-the-art technology."*

The report went on to recommend that both federal and state governments increase their emphasis on improving and diffusing existing manufacturing technologies and that:

> *"ways must be found to enable SMEs to become technologically competitive....and....federal efforts to promote technology transfer should be broadened to consider how federal resources could be used to help small and medium-sized manufacturers solve problems encountered in adopting technology."*

The Science Council of Canada and the Canadian Advanced Technology Association jointly state in their July 1990 publication "Firing up the Technology Engine":

> *"Canadian firms have a low level of technical awareness....(they) have limited ability to make independent evaluations of technology trends. Most companies rely on suppliers or consultants to help them make technology investment decisions. However, many companies lack the skills and information to assess suppliers' recommendations or to profit from the knowledge of consultants....steps should be taken to ensure the accessibility of services to help firms assess the possible benefits of adopting new technologies, and to design and evaluate options."*

Several other industry associations and advisory groups in Canada have called for increased attention to the needs of manufacturing companies throughout the country for technology and have recommended improved and increased efforts in technology acquisition and adoption to deal with the problem. The Council of Science and Technology Ministers, NABST, CATA, CMA, the Science Council and the Economic Council have all made recommendations to this effect. While technology by itself cannot be a panacea for the ills of Canadian industries, it is clear that the proficient employment of newer, more efficient, up-to-date, or best-practice technologies by Canadian firms would go a long way to alleviating some of the problems

faced by them in these difficult economic times. It is also evident that the need for technological upgrading by SMEs in Canada is a nation-wide problem. With the exception of those cases where nearby scientific and technical resources match the specific technological needs of firms, it is a problem which requires a nation-wide response towards resolution.

Studies in Europe and the U.S.A. have shown that roughly half of business productivity gains can be directly attributed to technology improvements. But the best technology in the world is useless if you don't know you need it, don't know where to find it, don't know how to get it, or don't know how to implement it! Governments must help firms address these issues.

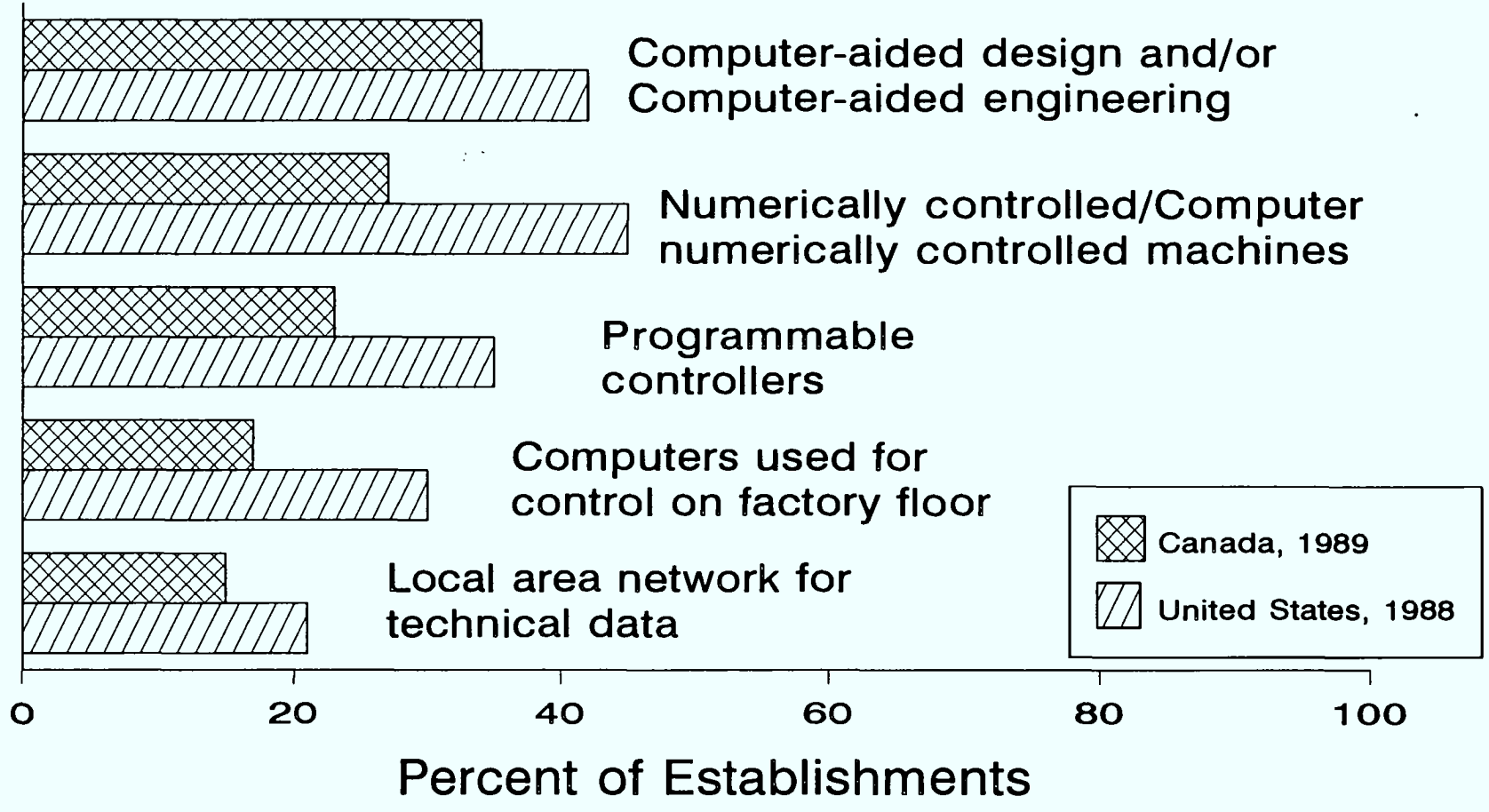
SMEs play an important role in Canada. Between 1979 and 1989, businesses with fewer than 50 employees created 81 per cent of all the net new jobs in Canada. By 1989, such firms employed about 40 per cent of all working Canadians, up from 34 per cent in 1979. SMEs are especially important in the regions. The number of businesses per one thousand of population in 1989 was highest in Nova Scotia, the Yukon, Saskatchewan, British Columbia, Alberta and Newfoundland. The regional contribution of SMEs continues to increase: the highest rates of growth in new business registrations in the period 1979 to 1989 were found in Newfoundland, Prince Edward Island, and Saskatchewan.

SMEs are often the incubators for new products and processes. While most Canadian policy and media attention focuses on our relatively few resident multinational firms, the growth, the potential, and the needs of SMEs are critical to the Canadian economy. Not only do they dominate the private sector in aggregate, but strong, agile SMEs attract and foster the growth of large multinationals. Policy makers in Japan and Germany clearly recognize the need for effective networks supporting SMEs. Moreover, again and again SMEs have been able to exploit market niches globally and develop into large and medium sized firms in their own right. There is clearly a need for greater attention to SMEs in Canada.

2.3 How are we doing?

There is now conclusive evidence that Canadian levels of investment in technology are low relative to other industrialized countries, especially for SMEs. Recent surveys have shed light on Canadian companies' performance in acquiring and using advanced manufacturing technologies. A study commissioned by Statistics Canada shows that Canada lags the United States in the use of advanced manufacturing technologies (AMT) by an average of 5.6 percentage points. This gap persists, in varying degrees, across five major

Percentage of Manufacturing Establishments in Five Industries * Using Selected Technologies



** Fabricated metal products, industrial machinery and equipment electronic and other electric equipment, transportation equipment, and instruments and related products.*

Source: *Statistics Canada*

industrial groups and eight categories of technology. The use of AMT tends to be greater in larger firms, but size accounts for only 40 per cent of the Canada/U.S. gap. In other words both large and small Canadian manufacturers tend to use fewer AMTs than their American counterparts, but since we have relatively more SMEs we are that much further behind.

Moreover, there is little comfort in tagging along behind the United States. While international comparative data are very limited, America's loss of competitive advantage in technology development, commercialization and use is perhaps the most prominent issue in U.S. economic policy debates. For instance, the U.S. Council on Competitiveness argues that American firms lag behind Japan and Germany in several critical areas such as robotics and computer-aided manufacturing.

To some extent, investment in R&D can be used as a proxy for technological capability because while it is not necessary for all technology acquisition, companies rarely undertake R&D without technology acquisition in mind. The data on Canada's low propensity for R&D are by now well known. However, we should point out that our university and government-performed R&D appear adequate. The gap centres in business performed R&D and indicates a lack of commitment to technology on the part of Canadian firms. Moreover, the gap in business-performed R&D between Canada and the leading countries has increased over the last decade.

A recent survey done for ISTC by Vinod Kumar of Carleton University, based on the work of U.S. economist Edwin Mansfield, revealed that Canadian innovation projects tend to focus on low-risk, short-term projects in comparison with the U.S. and Japan. The study also pointed to the lack of internal technical expertise as a major shortcoming of firms in Canada. This conclusion is echoed in almost all of the 15 Sectoral Studies now being concluded by the Science Council. Canadian firms have short-term, opportunistic technology strategies, wholly inadequate for survival in today's technology-driven business environment. Recent studies by Michael Porter and the Economic Council also conclude that low levels of technology underlie our relatively poor performance in the past decade.

2.4 Reasons behind Canadian performance

Before prescribing remedies, we must understand the reasons behind our low levels of technology. Three recent studies have come up with complimentary answers to this vexing question.

Taken together the Science Council's Sectoral Studies paint the picture of a structural imbalance rooted deeply in our economic history. In broad strokes, our internal market is too small to support production that enjoys competitive economies of scale. Even where we have been able to develop a world-scale firm like Massey-Ferguson, success has been fragile at best. At the same time our resource industries, mining, wood, and agriculture have prospered by being the lowest cost, and sometimes the only, producer of commodity products. Such products now dominate our exports and underlie our enviable standard of living, but will not do so in the future because demand is levelling off, alternative supplies are forthcoming, and customers are seeking highly differentiated products.

Unfortunately there are several significant barriers to a revitalized resource sector. Several countries such as Japan and the EC systematically exclude high value added goods, and even with the FTA, the United States seems prepared to limit imports from Canada. In addition, selling to more demanding markets requires close collaboration with the customer and supplier base, especially for equipment. In Canada both these bases tend to be abroad and thus our companies find innovation particularly hard. Clearly we need to foster technology-driven SMEs that can support our major resource firms as both customers and suppliers.

In addition to the lack of strong domestic links between the manufacturing and resource sectors, the long-term costs of protecting manufacturing industries pose problems. Until recently, the premiums earned from resource-based commodities hid weak manufacturing from view. In fact, as long as the value of resources was unchallenged, the national system ensured that the returns from the resource sectors filtered efficiently into other sectors.

The Economic Council's report "Pulling Together -- Productivity, Innovation and Trade", confirmed the decline in resource earnings and the lack of growth in manufacturing. The Council cited the relative inability of Canadian firms to innovate and adapt to changing circumstances, including low levels of investment and training, and in this way their analysis supports the views of both the Science Council and Porter. In addition they cited problems in management.

"the role of the manager in nurturing innovators and innovations is crucial in determining how effectively the firm performs....Studies devoted to the impact of management suggest, however, that Canadian companies have deficiencies in the management of innovation. They often fail to translate the development and adoption of new technology into their production. This is attributable to the way Canadian firms are organized and to the attitude of senior managers towards innovations. The isolation of senior managers from those among their customers and suppliers who might influence their strategies about new technology is a symptom of this problem."

2.5 Is there hope?

The Task Force's view is that much can be done. Most firms and especially SMEs are interested in improving their productivity and increasing their profits. The experience of people in ISTC, NRC and other organizations that deal directly with innovating firms has shown that technology assistance can be the key to new attitudes in the firm. Moreover technology lessons stick!

A recent study of small Quebec manufacturers, "Technological Experience and the Technology Adoption Decisions in Small Manufacturing Firms" (Lefebvre, Harfey, and Levebre), compared frequent and novice innovators. Novice innovators tended not to understand the implications of new technology. They only acquired new technologies when "spare cash" was available, and they gave insufficient attention to the need to change pre-acquisition practise. Frequent innovators, on the other hand, focused on the need for adoption, they used suppliers well, and ensured that their customers wanted their new abilities. In other words, **firms learn to innovate** and once they have learned continue to do so. Such firms drive growth.

The Task Force has concluded therefore that we have an addressable problem. Other countries have launched their industry into technology-driven growth, and lessons can be learned from their success. Individual Canadian firms continually demonstrate the ability to compete in any market. **Our task is to create the environment that supports and fosters competitive companies.**

3. A FRAMEWORK FOR THE STRATEGY

3.1 Demand-driven, client-orientated approach

This strategy approaches the issue of technology diffusion **from the perspective of the individual company.** While many traditional approaches tend to emphasize the supply and marketing of technology, the emphasis in this strategy is on the **demand** side.

3.2 The technology investment decision

From the perspective of the company, the building of technological capability is a question of investments. Various processes are involved, i.e., awareness of technology and its role in the company, sourcing, acquisition, adoption, adaptation and marketing. All of this needs to be situated in a business strategy. The demand for technology is very much a function of the strategies of businesses and governments.

The technology investment decisions of companies are affected by a great many factors. The specific factors, and their relative importance, can vary according to industry, company size, and other variables.

3.3 Factors affecting the technology investment decision

Extensive research, a series of interviews with individual companies, and recent program and service delivery experience have led to a consensus in the Task Force on the factors that are the key influences across the range of small and medium-sized companies in Canada.

Most companies will cite factors such as market opportunities, competitor behaviour, and other sources of competitive pressure as the underlying reasons for their technology investments. The Task Force accepts these as given, and recognizes that an important role of government is to promote the efficient functioning of the market through measures such as liberalization of trade and macroeconomic policies. In addition, governments can directly support the market responsiveness of firms and the attitudes and orientation of owners and managers through trade and market policies, programs and services. The focus of the Task Force, however, has been on the microeconomic issues that arise out of and are related to these underlying reasons. Thus the Task Force has concluded that the following factors represent the key influences on firms' technology investments.

1. The orientation and basic **receptiveness of the firm to technology** with particular emphasis on:

   . recognition of the strategic importance of technology in market success and as a business solution;

   . attitudes and technological literacy of managers; and

   . development of a technology-oriented corporate culture ("turning on" to technology);

   all founded on an understanding of competitor behaviour and market dynamics.

2. **Management capabilities**, processes and decision-making, i.e.:

   . the ability of managers and the organization to incorporate technology into a business strategy for the company;

   . awareness and knowledge of specific technological options and opportunities, and the ability to make wise choices among them; and

   . mechanisms and support for the sourcing and implementation of technology.

3. The managerial and technical **skills base available** to the company, including internal human resources and resources available in the labour market.

4. Availability and cost of **financing.**

5. **Regulations and standards.** These can result in both incentives and disincentives to investment in technology.

6. **Linkages between receptors and sources of technology** and associated support.

   . Many studies show that, for small and medium-sized companies, suppliers are the main source of technical information and technology.

   . Other important sources include universities and colleges, government laboratories, technology centres and intermediaries such as brokers and consultants.

4. ROLE OF GOVERNMENT

While governments in virtually all countries have traditionally had a prominent role in the development of technology through support for research and development programs, including industrial activities, in some countries they have been less willing to become engaged in activities related to the acquisition, management and use of technology by companies.

It is likely that the principal reasons are that the relevant processes have been considered transactional in nature and therefore the "business of business", and that the public goods or social returns accruing from such processes have not been evident in traditional forms of economic policy analysis. In addition, governments have not fully recognized the role of business policies and public infrastructure in stimulating the diffusion of technology. There may also have been a view that technology could be more quickly exploited and protected if domestically developed.

The Technology/Economy Program of the Organization for Economic Cooperation and Development, consisting of a series of conferences which brought together all the key recent research and the views of leading industrial, academic and government analysts, pointed out that industrialized nations' ability to manage and use technology is not keeping pace with their ability to generate it through R&D. The success of Japan in adopting and adapting technology acquired from elsewhere also highlighted the commercial payoffs associated with acquiring technology and putting it to work.

4.1 Increased government involvement in diffusion

The OECD is now promoting increased government involvement in diffusion, on the basis of new evidence of public benefits from the use of technology, and a growing realization of the important role played by governments through the establishment of business climate and infrastructure. A communique issued by the OECD Ministerial meeting in June 1991 carried a policy statement on Technology and the Economy which included the following passage:

> *"Ministers reaffirm the importance of fostering diffusion and a wide acceptance of technology within their economies and societies. Governments should consider developing policy measures to facilitate technology diffusion, such as technology extension services, particularly as regards small and medium size enterprises, and removing market impediments, such as excessive regulatory burdens. They should also encourage a broad range of information on and public discussion of*

technology issues, support technology assessment at national, regional, and international levels, and promote in their societies a climate which is receptive to technological change."

In view of the many factors that influence companies' investments in technology, governments must be aware that many instruments at their disposal are in play. Most importantly, **governments establish the business climate that conditions investment behaviour.**

Governments also help put in place the public infrastructure through which the users of technology avail themselves of information, services and technology itself, and through which technology receptors are brought together with sources of technology and with providers of supporting services. This infrastructure consists of public and private institutions, their capabilities and the services they provide, and networks for communication, information exchange and collaboration.

Governments also play a key role in challenging companies to excel, in setting economic direction for the country, and in conditioning the attitudes of present and future decision-makers. Education and training are key in the development of the requisite expertise and orientation.

Robert Reich's widely discussed recent papers, *"Who is Us?"* and *"Who is Them?"* emphasize that government's job is to build the human resource base and infrastructure to encourage the right kinds of investments and business activity.

4.2 Activities of other governments

In countries that have achieved success in the management and use of technology (e.g, Japan and Germany), the orientation toward investing in technology is embedded in the business and labour culture. These countries have combined policies, institutions, programs and services into a system that operates like a well-oiled machine. Such economies are said to be "diffusion-oriented".

Many industrialized countries have begun to put greater policy emphasis on the acquisition and diffusion of technology. Research and development is becoming increasingly expensive and is out of the reach of many SMEs. Domestically developed technology does not automatically guarantee a competitive edge, as the Americans learned painfully from the Japanese.

Many industrialized countries have realized that a need exists to improve both their diffusion/transfer/acquisition systems and systems **designed to increase the utilization of technology by their industries.** Most have established organizations or networks through which firms have increased and improved their access to technologies. Such networks usually operate at the national or regional level.

Networking agencies throughout Europe invariably collaborate and co-operate in exchanging requests for (and offers of) technologies from their client firms. This practice has resulted in the formation of several pan-European technology networks. Although the processes are demand-driven and aimed primarily at the SMEs, some larger companies take full advantage of the systems.

One such network encompasses regional industrial development agencies in provinces in Italy, France, England and Germany. In Southeast Asia a similar network, ***Technonet Asia,*** links industrial development agencies of seven countries and acts as a conduit for technology diffusion and acquisition. The international experience in this type of collaboration is something that Canada should examine more closely. The links with agencies directly engaged in requesting and offering technologies could not only provide inroads into sources of appropriate technologies for Canadian firms, but also open up potential markets for Canadian technologies, goods and services.

Australia has recently developed an industrial support network, the ***National Industry Extension Service.*** State agencies are linked together in an overall federal network which combines business support and technological assistance for SMEs. The support instruments developed by the federal government and the interactive relationships between the state and federal agencies should be of interest to Canada.

Several other European networks are commendable. **TEKES** in Finland, the **Fraunhofer Society** and the **Steinbeis Foundation** in Germany, the **DTI** in Denmark and the **Scottish Development Agency** all combine technological support with business assistance and development. The SDA also engages in industrial development activities which include industry site development, offshore marketing, international technology transfer, industrial educational training and strategic technologies development. This agency has achieved world renown and is a model for other regional development organizations in the U.K.

4.3 United States of America

In the **United States,** more than 23 federal programs are directed at developing a support system for science and technology. The national resources include centralized facilities and well-organized systems for technology transfer and the international acquisition of technology and agencies for **technology assessment.** The **Federal Laboratory Consortium for Technology Transfer, (FLC)** was established to facilitate the further development and use of technologies developed in federal laboratories. The FLC has over 500 member laboratories in 14 federal government agencies. It was designed:

> *"to consolidate and coordinate the diverse technology transfer activities of the government's various laboratories and research centres, giving private business and other end users a single contact point for technology transfer and information services. It was designed to supplement rather than to supplant the technology transfer services run by individual laboratories."*

The FLC has been having some start-up difficulties. This is probably because of the immensity of the S&T infrastructure in the United States and the fact that although the FLC was described as a "single access point" it was not truly designated as such. Nevertheless, the **concept of a technological clearing house dedicated to technology transfer** has some appeal.

The U.S. Department of Commerce runs the "Boehlart-Rockefeller Extension Service Program", also known as the **State Technology Extension Program.** The program provides financial and technical assistance to individual state-run technology extension programs. Commerce also operates the **National Technical Information Service (NTIS),** one of the most comprehensive technical resources in the world. It includes information on federally supported R&D projects and on technologies available for licensing and is accessible on virtually every on-line data base system in North America. Commerce has established **Regional Manufacturing Technology Centres** to help SMEs.

Another recent trend in federal technology funding in the U.S.A. has been a shift to applied R&D from basic research. A 1990 SRI report on Federal Programs states:

> *"Despite the opposition of the Reagan and Bush administrations to 'industrial policy', federal R&D dollars are flowing in larger amounts to the development of technologies at stages closer to commercialization. Direct involvement with businesses, rather*

than just academic institutions, is increasing....Congress has been instrumental in pushing forward this commercial agenda against administration opposition....several new proposals for federal assistance can be expected from the 102nd Congress beginning in January 1991."

In the United States concern over the international competitiveness of U.S. firms has been directly linked with their technological capabilities. Aid to small and medium-sized firms has become a high priority in federal technology support in the U.S.A. The U.S. Congress has led the way in this regard through legislative efforts such as the Small Business Innovation Act of 1982.

4.4 State level networks

A large number of technological assistance agencies were established in individual states during the 1980s and the trend continues. The state networks offer a variety of "technical services" to industries including:

Networking and Referrals
Seminars and Workshops
Technical Counselling
User Request and Response Systems
Technical Literature Dissemination/Review
Product Design and/or Evaluation
Technical Data Services
Demonstration Projects
Invention Evaluation
Liaison to Federal Laboratories
Joint Venture/Partnership Counselling

Despite these efforts, the U.S. Congress Office of Technology Assessment in a 1990 report, ("Making things better; competing in Manufacturing"), maintains that manufacturing industries in the U.S.A. are still poorly served, and stresses that efforts must be made to more successfully adapt existing technology. The report also emphasizes the apparent need for increased federal involvement in industrial technological development particularly with the small and medium-sized manufacturers.

In addition to technology support services, every State provides **business assistance services to SMEs.** These include:

Business Plan Preparation/Evaluation	*Small Business Consulting*
Management Assistance and Studies	*Financial Analysis*
Feasibility Studies	*Marketing Surveys*
Joint Venture/Partnership Counselling	*Site Location Assistance*
Business Forecasting	*Labour Analysis*

One common aim or goal of most of these networks and services is that of **acquiring best-practice technologies.** Federal efforts are recognizing the diversity which exists among networks and is establishing support systems which address problems of common interest to business clients and would be of value to all networks regardless of their individual operational mechanisms. Such a national service to these networks might be termed a "network in support of networks". Several bills currently before Congress may result in the creation and establishment of a **National Technology Support Agency.**

4.5 Summary of international scene

Technology diffusion mechanisms vary considerably from country to country. Nevertheless, some common trends are beginning to emerge, for example:

- a trend by governments to spending incremental S & T resources on the strengthening of technology transfer and diffusion infrastructure, sometimes at the expense of large technology development programs;

- a trend toward the creation and use of technology extension networks to assist industry in acquiring and adopting new technology in lieu of sector-specific programs; and

- a trend toward better integration and coherence in the range of policies that influence technology investments, with economic departments acting as policy focal points, and the delivery of information, services and programs delegated to agencies that are either at arms-length from or entirely separate from government.

4.6 Activities in Canada

4.6.1 Federal activities

The Task Force undertook a study of industrial technology support programs and services of the federal and provincial governments using the Department of Supply and Services "Guide to Federal Programs and Services" for 1991 and consultations within ISTC and with other government departments. Information was gathered in a similar way on provincial programs through the ISTC regional offices and other sources. There is a wide array of programs and services for SMEs throughout Canada. Most of these deal with the supply of technical information in specific sectors. Some programs deal with technology enhancement but to a small number of industrial firms.

The dominant nation-wide network **specifically developed to deal with the technological needs of Canadian SMEs is the IRAP Network of the National Research Council of Canada.** Industry Technology Advisors (ITAs) of the IRAP Network serve predominantly small and medium-sized companies throughout Canada. It provides ready access to a **comprehensive network of expert resources.** Activities are broad-based and in general focus on providing quick and flexible responses to an extensive range of technical problems of companies by providing technical advice, assistance, referral and/or funding.

In this way it is similar to those of the state technical services in the United States but is national in both size and scope.

ITAs also deliver the majority of projects funded under the **Technology Inflow Program (TIP)** of the Department of External Affairs and International Trade which provided funding assistance pertinent to the acquisition of foreign technologies by firms. Temporary funding to maintain the grants and contributions portion of TIP has been instituted by IRAP.

4.6.2 Provincial Activities

Provincial governments are increasingly becoming more concerned about the "technical health" of firms within their provinces, as indicated by the current activities in British Columbia, Alberta, Ontario, Quebec, Newfoundland and New Brunswick to develop strategies to assist firms to acquire and make better use of technologies. Newfoundland and British Columbia, for example, are currently reorganizing their technology assistance networks. Enterprise Newfoundland and Labrador has recently pooled

resources with three other agencies to provide technological assistance to the fisheries.

Atlantic Canada's programs tend to be focused on the early stages of technology development and reflect the sectoral makeup of the region with emphasis on the fishery, food products and oil and gas exploration. There are general support programs as well. Increased support for technology diffusion would be highly visible but its impact would be constrained by shortcomings in local infrastructure, management attitudes, work force skills base, overall technology culture and general economic climate.

Quebec has taken a unique approach to program support for technology diffusion specifically and technology in general. It has employed by far the largest number of programs (123) of the regions. These programs are highly specific sectorally and regionally, and in some cases sectorally within a region. Quebec's programs emphasize the higher stages of technological development although there is broad support across all SME objectives. Much of Quebec's program support relates to the institutions of its technological infrastructure, such as AQVIR, CRIQ, CRIM and several others. In addition to provincial programs, Quebec receives specific program support from the Federal Office of Regional Development (FORD-Q) and employs IRAP throughout the province.

Ontario's programs show slightly more support for SME objectives in the middle and higher stages of technological development, although there is fairly even support across most areas. As with the majority of the federal programs and programs in Quebec, support is weakest in actual technological assistance to SMEs. In contrast to Quebec's approach employing a large number of highly specific programs, Ontario's approach is to have fewer programs with broader applicability. The focus of these programs is on manufacturing, small business, exports, construction, tourism, training and the environment.

The West, consisting of four provinces, is the most diverse, geographically, economically and culturally, of the four regions under discussion. Western programs are highest in technical assistance to SMEs and are lowest in increasing SME technical awareness. Some of Manitoba's programs are sector specific, with the emphasis on agriculture, advanced industrial materials and biotechnology; others are general. B.C.'s programs have a more scientific focus. Alberta and Saskatchewan have smaller numbers of programs which have a general orientation.

4.6.3 Gaps in information and support

Provinces tend to introduce programs and services which are very specific in nature. None to date has been identified as being comprehensive either in its range of targeted companies or scope of outreach. The Ministry of Industry, Trade and Technology for Ontario even promotes the IRAP program as the prime industrial technical support service in the province.

Analysis of the programs and services throughout Canada appears to indicate that SMEs would benefit from more program support in the area of **management skills**, particularly in the **management of technology**. While provincial programs and services seem on the surface to encompass most of the areas of technological support, closer examination of the specific programs indicates that they are for the most part sub-optimal and in many cases extremely small both in outreach and effectiveness.

4.6.4 "Private sector" networks

Although most "technology networking" activities throughout Canada are components of specific programs within the federal and provincial governments, some take place in private or semi-private agencies. Examples of some of these nation-wide networks in Canada include:

- **Association of Provincial Research Organizations (APRO)** which is aimed at technological development of industries including Research and Development; the PROs are important partners in the IRAP network;

- **Canadian Manufacturers' Association (CMA)** geared towards business development including technology;

- **Canadian Construction Research Board** a national network of public, private and academic sector experts in or supporting the construction industry; and

- **Association of Consulting Engineers of Canada (ACEC)** business and technological consulting to firms across the country.

These agencies, organizations or networks differ in structure, outreach and services offered to their clients/constituents. There generally appears to be little formal or structured partnership or cooperation between the agencies or organizations.

4.7 Task Force conclusions on role of government

Governments in Canada and other countries influence investments in technology in various ways. The Task Force has concluded that the roles of government fall into four general categories:

- **"mind set"**, or the knowledge, attitudes, orientation and experience of management and labour in the private and public sectors;
- **"skill set"** at the managerial, professional, technical and skilled trades levels;
- **business** (investment) **environment**; and
- **supporting infrastructure.**

4.8 Principles governing federal government activities

In putting forward this strategy, the Task Force has embraced the following principles, based on experience of what works best.

- Activities should be aimed at **helping companies to help themselves,** by developing internal resources or (where internal capabilities can not be feasibly developed) by systematically availing themselves of expertise and capabilities available elsewhere in the economy through appropriate linkages. Creating situations where companies are indefinitely reliant on government support mechanisms is to be avoided.
- In the case of the provision of services, the objective of ISTC is in the first instance to **ensure that the required services are provided, not necessarily to provide them directly.** All services should be required to meet the test of the market.
- Within the framework of the focus on small and medium-sized enterprises, **no companies are to be *excluded* from consideration.** That is to say, the range of instruments to be used is to be made available to all companies, with the understanding that service providers will assist companies to select those instruments that are most relevant to their own current capabilities and competitive situation; thus any targeting by service providers will be market-driven.
- **Government departments and agencies share a client base,** and should not be competing for clients.

5. OBJECTIVES OF THE STRATEGY.

5.1 Principal goal

To promote the competitiveness of small and medium-sized enterprises in Canada by **building the capability**, within companies and government organizations, **to deal with technology investments in the context of the whole enterprise.**

5.2 Subsidiary objectives

To foster an integrated, cooperative approach to policies, programs and services across the federal government and in cooperation with the provinces.

To bring about changes in attitudes and orientation among management, labour and governments in Canada such as to create a diffusion-oriented **"mind-set"** or culture in Canada, and to promote and favour investments in technology, in order to improve the receptor capability of companies and public sector organizations and of the economy as a whole.

To help to build the **skill set** within and available to companies as a fundamental element of technology capability.

To increase the availability to companies of information, intelligence, expertise and advice that they are not able to develop internally, in order to augment their internal **skill set.**

To establish a **business climate** that is conducive to long-term investments in technology.

To promote national unity through:

- the strengthening of the service and network **infrastructure** that links companies to sources of technology throughout Canada and abroad and which facilitates mutual support among the various regions of Canada, and through

- federal-provincial cooperation in networking and service delivery.

Recommendation 1. ***That these objectives be adopted as the foundation for a strategy on technology diffusion in Canada.***

6. ELEMENTS OF THE STRATEGY

6.1 Policies affecting the business (investment) environment

6.1.1 The issues

Business investment in technology capability is influenced by a great many government actions that affect the environment within which decisions are made. Some of the more important business policies include:

- interest rates and exchange rates, which have profound impacts on investment behaviour;
- trade policies, which condition both the kinds of activities in which domestic businesses engage (for example, tariff barriers set up by other countries have traditionally discouraged technology-intensive investments by resource companies in further processing of raw materials), and the ease of access by Canadian firms to foreign technology;
- competition policy, which affects the relationships between suppliers and users of technology;
- financial institutions policy, which affects the linkages between sources of financing and the technology-using industries;
- tax policy, which can provide incentives or disincentives for certain kinds of investments and locational decisions;
- regional development policy, which helps determine the kinds of industries and infrastructure that will be put in place across the country, and the degree to which regions are inter-connected;
- education and training policies, which determine the supply of skilled people and influence private sector investments in human resource development; and
- a host of standards and regulations.

6.1.2 Priorities for action

While it is beyond the scope of the Task Force to delve into all these complex areas of policy, it must be emphasized that these policies strongly affect technology diffusion. In fact, these **business framework policies are the most important measures that governments take in relation to technology diffusion.** Programs and services will not be optimally effective unless the framework policies are right.

The overall impact of coordinated government policies can be greater than the sum of its parts. Coherence, and a comprehensive approach, has inherent value in providing national leadership and sending consistent signals to industry. Because of this the Technology/Economy Programme of the OECD focused on the interaction of technology and technological capability with a broad range of government policies and emphasized the need for greater coherence among the various activities of governments.

> ***Recommendation 2. That the federal government continue to strive toward coherence in its various policy actions, following the principles outlined in the OECD TEP process.***

The Task Force does have views on certain key business policies. Trade policy is touched on later in relation to the acquisition of technology from other countries. SME's frequently express concern with financing, regulations and standards. Finally, the Task Force makes some proposals in later sections of this report which are intended to improve the ways in which government interacts with business.

6.1.3 Financing

Many industry associations and commentators contend that availability of financing is an issue for SMEs, particularly technology-driven firms, and that viable projects/firms are denied financing due to inadequacies in the Canadian financial markets. On the other hand, providers of financing generally disagree with this contention, maintaining that worthy projects have little difficulty obtaining financing, given the competitive environment of the financial markets.

Debt financing perspectives - The demand side cites lenders as having little technical knowledge, thereby unnecessarily increasing risk and uncertainty in lending to non-traditional / technology / innovative projects. In addition, given the soft-asset nature of knowledge-based firms, lenders are unwilling to lend to such firms in the absence of tangible security.

Lenders respond that they are not in the risk capital business and that they must follow prudent lending practices due to their obligations to depositors and shareholders. Lenders also express concern about the management capabilities of SMEs.

Equity financing perspectives - The main external sources of equity financing are family and friends ("love money"), wealthy individuals,the venture capital industry, and the stock markets. Until recently, the venture capital industry played an important role in bridging the gap between the love money and wealthy investors and the public stock markets.

Venture capitalist have virtually deserted, at least temporarily, the early stage technology markets for later stage traditional investing. Investments of less than $750,000 are considered by the industry to be economically unsound.

The demand side attributes the industry desertion to their perceived short-term perspective and their lack of technical knowledge to properly assess investment opportunities. The venture capitalists justify their position by pointing to poor returns on investments in early stage companies, as well as the excessive time required to monitor these relatively small investments. The industry also maintains that there are too few "good deals" in Canada, citing the industry's $800 million capital presently seeking opportunities with limited success.

The federal and provincial governments are attempting to increase the availability of and access to financing for SMEs. This is done directly by providing grants, loans, and equity funds to SMEs, indirectly by supporting private sector sources through guarantees, tax incentives, etc. ISTC's role in cooperation with other interested parties is to identify those business sectors which can significantly contribute to Canada's competitive position and which are not adequately financed by present sources and programs, and then develop means to correct the situation.

Governments at both the federal and provincial levels have instituted a number of programs to address the "gaps" in the availability of financing for SMEs.

Debt financing At the federal level the Federal Business Development Bank (FBDB) and the Small Business Loans Act program, with a combined portfolio of $ 4 billion, play an important role in providing broad-based debt financing for small business. Loan insurance programs are available through ACOA and FEDNOR, while Western Economic Diversification funds eligible projects with repayable contributions. The provinces also provide a range of loan and loan guarantee programs to SMEs.

Equity financing The federal government has in place a number of indirect measures to stimulate equity financing in SMEs, such as the preferential capital gains tax exemption on qualifying small business shares and incentives for pension funds to invest in SMEs. It is noteworthy that recent activity in early stage financing has been driven primarily by government-backed venture capital groups. This trend is even more pronounced for early-stage technology companies. Government-backed agents in this area include the Venture Capital division of the FBDB, and various provincial initiatives such as Innovation Ontario, Quebec's Solidarity Fund, the Alberta Opportunity Company, and British Columbia's Discovery Foundation. Governments also provide a variety of services designed to improve management skills through self-help materials, counselling services, and training programs.

What is being done?

ISTC is currently reviewing the SBLA program and this review could result in program changes to make increased financing available to technology SMEs.

FBDB has introduced a new venture loan program which uses quasi-debt/ quasi-equity financing instruments suitable for small technology firms with high growth potential.

ISTC has recently submitted a proposal for stimulating equity investment by individuals in SMEs through the use of tax incentives.

ISTC is presently promoting the undertaking of a series of roundtables to bring users and suppliers of financing together to discuss their needs and increase mutual understanding.

Recommendation 3. That tax incentives for SMEs acquiring technologies be supported and sustained.

Recommendation 4. That efforts to increase understanding between SMEs and suppliers of finance be supported and endorsed.

6.1.4 Standards and regulations

The role that standards and regulations perform in determining the technological and economic competitiveness of firms is becoming increasingly recognized, especially by our international competitors. European countries, Japan and others are seeking competitive advantage by taking a more active role in standard-setting. Of particular importance is the need for increased understanding of the substantial role that standards and regulations play in both

promoting and impeding technology diffusion. The nature and details of the role are not well understood.

Issues which must be addressed include:

- What are the strengths and weaknesses of current Canadian structures for identifying, managing and developing standards and regulations?

- What are other countries doing to enhance their technological competitiveness through standards and regulatory activities?

- What should Canada's policies be with respect to developing versus adopting standards?

- Are we maximizing the use and benefits from existing standard and regulation setting machinery to enhance technology diffusion?

Recommendation 5. That a major study be undertaken of the impact of standards and regulations on the diffusion of technology.

This is further developed and discussed in ANNEX III.

6.1.5 Diffusion infrastructure and business-government relations

In a later section of this report, the Task Force describes a concept for a nation-wide technology extension system. In addition to facilitating the delivery of information, services and programs and fostering linkages among organizations, this extension system can play an important role in policy setting and implementation.

First, the network would provide a feedback system whereby officers throughout the country could identify issues of concern to firms and instances of distress and bring these to the attention of policy makers, and could play an advocacy role in bringing about change.

Second, the officers, with proper training and access to up to date information, could play a role in alerting client firms to policies and policy changes and ensuring that they are understood.

Third, by facilitating access to government programs and services, the network could improve the interaction between business and government, and among government bodies, and build confidence in the role of government in assisting the competitiveness of firms.

6.2 Management

6.2.1 The issue

Management is the key to successfully acquiring and implementing new technology. Evidence indicates that managers in Canadian firms are experiencing difficulty in strategically planning the acquisition and implementation of new technology. All technology diffusion problems ultimately become management problems of one kind or another.

6.2.2 Managerial mind-set

Managers who have not taken on the technology acquisition challenge can generally be said to fall into two categories.

In the first category are managers who are not even aware of the benefits that "best practice" technology can bring to their businesses. These managers need exposure to the possibilities of technology and its competitive impacts. **Their lack of basic awareness has been identified by the Task Force as a major issue for attention.** The federal government already offers services that address this awareness issue, such as the Canada Awards for Business Excellence, and Technology Opportunities Showcases.

In the second category are managers who are more aware of what technology is available but have not fully analyzed its value in their business or are reluctant to invest in new technology because of the uncertainties and risks involved. The lack of measurable short term benefits discourages many managers who have an orientation toward short-term payoffs, or perceive that directors and owners expect to see immediate results. ISTC offers a number of programs and services designed to help managers to initially gauge the potential pluses and minuses of a technology acquisition; these include diagnostic services such as Interfirm Comparisons (IFC), the Manufacturing Visits Program (MVP), the Manufacturing Assessment Service (MAS) and the Advanced Manufacturing Technology Applications Program (AMTAP).

The demand for technology is very much a function of the attitudes of management and labour in business and government. Business attitudes have roots in culture, education, and history. Attitudes of current managers are no doubt influenced by traditional economic orientations of the various regions of Canada, and by experience of what it takes to succeed. In Canada, these influences have not included an inclination toward technology. In recent World Economic Forum reports, Canada has ranked low on innovative forward orientation and international orientation.

The role of government starts with leading by example: articulating a vision for the country and putting that vision into action through policies and priorities, and through the way it conducts its own affairs. A department such as ISTC should be a model for the kind of organizations being advocated for the private sector. An outward and forward looking government will influence a similar orientation among business managers.

A second major contribution of government comes through exposing companies to international competition and competitor behaviour. This exposure is achieved through measures such as trade liberalization and the provision of information on market changes, technology developments and best practices. Firms interviewed by ISTC have consistently requested information of this kind. Services such as those listed above also help SMEs take that important first step in embarking on a technology strategy.

6.2.3 Skill set

Many managers lack the skills associated with acquiring and implementing new technology and need information, instruction and diagnostic tools. Services aimed at improving managerial knowledge and skills, some of which allow managers to "benchmark" their firms performance against others include AMTAP, MVP and IFC.

A recent study prepared for ISTC revealed a striking lack of courses related to technology in Canadian business schools. Compared with, say, Japan, Canada has a small percentage of senior business executives with scientific or engineering backgrounds. These factors account in large part for the difficulties many firms face in making effective use of technology. The low value placed throughout Canadian society on scientific and technical careers is reflected in the skill set of executives.

While the attention paid to technology in business schools is increasing (e.g., through the NSERC/SSHRC chairs in management of technology, and through programs set up at universities such as Carleton), managing in a technologically intensive environment is still not a priority in most business schools. University programs could also reach out more effectively to SMEs by being much more flexible with respect to delivery location (e.g., through satellite-based learning), and cost and types of courses (e.g., firms are asking for more short-course, business related courses).

6.2.4 Business environment

The economic and business environment has an obvious impact on the job of managers. In very general terms, favourable tax regimes, regulations

and clear standards make it easier for managers to perform well and to plan for the future. More narrowly, with respect to acquisition and implementation of new technology, there are a range of less general "environmental" factors (usually specific to a given locality) which can make a positive difference to managers in their attempts to acquire and implement new technology (i.e., clustering, coupling, mentoring facilities, special incentives).

6.2.5 Infrastructure

Managers need an infrastructure which provides technology advice and expertise and can assist them in making decisions. A certain level of infrastructure is already in place. For example, the TOP centres and other technology centres are important networks of advice and expertise but, as pointed out in the TOP Program Evaluation, these need to be tied more closely together with other networks in order to facilitate access to that full range of services and expertise that constitute the business response to technology.

Managers also need an instructional/training network which can provide management and technology education and training which is more relevant and immediate than that offered through standard university curricula. The institutional role of the universities is not keeping pace with changes in technology, industry structure and the importance of SMEs.

6.2.6 Policies

Neither ISTC nor any other government department has enunciated a policy or policies directed to the issue of management. ISTC policy, however, is implicit in its management related programs and services which imply a catalytic role for government on at least four fronts.

- Establishing a climate which will facilitate successful acquisition and implementation of new technology (i.e., tax structure).
- Helping to improve the ability of managers and their firms to incorporate technology into a business strategy.
- Making managers aware of specific technological options and opportunities.
- Providing support for mechanisms which help firms to source and implement new technology.

6.2.7 Priorities for Action

There is growing evidence of the fundamental importance of management capabilities to technological performance, and an increasing number of individuals and groups who are pointing to the importance of management.

> ***Recommendation 6.*** *That excellence in management be made a fundamental element of the technology diffusion strategy. This should include leading by example, e.g., through the attitudes and skills that the federal public service demands of its executives.*

Stick with what works in terms of **management diagnostic services.**

> ***Recommendation 7.*** *That the use of Advanced Manufacturing Technologies Applications Program as it currently exists be expanded, that an AMTAP implementation element be established, that the use of Manufacturing Assessment Service as a general diagnostic tool be expanded.*

Both of these diagnostic services have been extremely well received by business, and demand is growing. They constitute a low-cost way for the federal government to kick-start the technology strategy process in firms across the country. They also have the benefit of building consultancy capability in the private sector.

> ***Recommendation 8.*** *That the use of international benchmarking as a means of assisting firms to gauge their performance and competitiveness be expanded.*

This technique has been applied successfully in the National Industry Extension Service of Australia, and some consulting companies in the USA offer the service. A primary objective of government effort in this area in Canada would be to build private sector capability to provide the service.

> ***Recommendation 9.*** *That the government should also continue to investigate and develop ways and means of providing programs and services which help to change the mind-set and build up the skills of managers.*

One possibility currently under serious investigation is to establish a pilot project for the establishment of a **satellite based distance learning network** which would deliver management and technology education and training to sites accessible to large numbers of small and medium-sized firms

across Canada. Such a network would to serve industry but a secondary and very important purpose would be to bring Canadian universities into the business of providing such education.

The sensitization effort also begins often at the community level through the identification of **"champions"** in local companies and associations. Federal, provincial and private sector collaboration at the local level can help bring this about.

Currently in Canada we have a strong technology support infrastructure in the IRAP program. We only have the beginnings of an equivalent network in the area of management. A later chapter of this report outlines how a complementary capability can be established, starting with the strength that has been developed in ISTC and other organizations. This would include the **revitalization of the Technology Outreach Program.**

6.3 Human resources

6.3.1 The issue

The shortage of technical skills within companies is currently one of the principal impediments to investments in technology in Canada. Some provinces and regional development authorities have responded by establishing programs that support the hiring of technical personnel by companies.

People are the determining factor in the diffusion of technology. The provinces are responsible for education and on the federal side, Employment and Immigration Canada (EIC) and Labour Canada are responsible for the bulk of programs and services which support human resource development.

6.3.2 Current activities

Employment and Immigration offers the Unemployment Insurance Program (UI) Section 21 which deals with work sharing and training, the Labour Force Development Strategy, the Canadian Jobs Strategy (CJS), the Industrial Adjustment Service (IAS) and Employment Centres. Labour Canada offers the Program for Older Workers Adjustment and the Labour-Management Partnerships Program. Secretary of State sponsors the Literacy Initiative and Liaison with the Council of Ministers of Education.

The emphasis in EIC programming is on passive income support or active training for those outside the labour force (e.g. job entry and re-entry). The introduction of the Labour Force Strategy in 1990 has started to shift the emphasis to more forward-looking approaches.

At one time, the Canada Institute for Scientific and Technological information (CISTI) devoted considerable efforts to the development of what was termed a "Knowledge Source Index" of Canadian scientists, engineers, technologists and technicians all of whom were purportedly committed to serving industry's needs for technical expertise (within agreed-upon limits and boundaries) if called upon. This excellent concept has been abandoned by CISTI because of the time and expense of keeping the system updated. The idea is now being emulated in many parts of the world notably the U.K. with its B.E.S.T. system where all scientists or engineers employed in government agencies or who receive financial assistance in support of R&D (e.g., in universities), undertake upon call, to serve the needs of British industries for technical experts. The program appears to be working well. A system similar to B.E.S.T. is currently under development in the United States.

Several activities related to the defining of technical human resources are being undertaken within Canada, (such as the ISTC "Technical Source Mapping Project" and the "Road Map" and "Engineers in Canada" projects), and these should be encouraged and supported and further developed to establish a comprehensive picture of technological resources within the country. It is important to realize that any "network" designed to assist SMEs throughout Canada is *ultimately a network of people*. Although organizations visibly form the infrastructure of such networks, it is the skilled *human resources* within that those organizations who are the realizable technological strengths of the network and who ultimately will serve the needs of industries throughout Canada.

> ***Recommendation 10. That ISTC continue to support the development of activities leading to the identification of the nation's human technical resources including specialists, scientists, engineers and technologists. ISTC should encourage the development of policies, procedures and agreements whereby scientific and engineering personnel supported by federal moneys are expected to offer technical expertise to industries in return for that support.***

Of necessity, the issue of human resource development is increasingly being addressed in an indirect way through the inclusion of human resource development elements in technology related services because the human resource element is critical to their success. For example, diagnostic services such as MAS and AMTAP must diagnose firm technology receptor capability largely in terms of the human resource capabilities of the firm. Support for scientific and technical human resources is also a fundamental feature of the IRAP program.

6.3.3 What should be done?

Successful acquisition and implementation of new technology are very dependent on operational and cultural changes driven by labour/management partnerships, which are manifestations of the **mind-set** of the organization. Bringing new production technology into the firm is often impeded by a failure on the part of both management and labour to properly prepare workers. Technological change is frequently a prominent issue in the adversarial postures that characterize industrial relations in Canada. Adjustment and change must now be seen as a way of life. The basic attitudes of management and labour underpin receptiveness to change.

The **skill set** needs to be built up at three levels: the basic level of literacy and numeracy; technicians and technologists; and highly trained researchers, scientists and engineers. Current evidence points to significant problems at the first two levels and some shortages (sectorally based) at the third level. At level one, many firms indicate that basic literacy and numeracy skills are deficient and training is required to correct the situation. CEIC programs are mainly directed at this level. At the second level, it is widely reported that there is a significant shortage of technicians and technologists. This will partly be addressed by The Canada Scholarships in Technology Program but there remains the longer range issue of attracting people in these areas. Shortages, on a sector by sector basis, are evident at the third level. The Canada Scholars Program is partly addressing this issue but there is a longer range cultural and educational issue which must be dealt with if Canada is to develop more of a science/engineering culture. The Public Awareness Campaign, and the National Science and Technology Weeks of ISTC are also aimed at increasing the flow of students towards science and technology.

While a full analysis of the human resource development **infrastructure** is beyond the scope of this report, the Task Force would like to emphasize the importance of linking human resource development services and networks to those that deal with technology and other business issues, in order to provide a "whole enterprise approach" to the development of technological capability.

6.3.4 Priorities for action

The Task Force recommends that efforts continue to attract young men and women into careers in Science and Technology.

> ***Recommendation 11**. That federal and provincial agencies continue to develop the kind of awareness/education initiatives they have been developing throughout the country. These services, both federal and*

provincial, are generally aimed at encouraging young people to consider careers in science/engineering/mathematics and teaching careers in these disciplines.

In the **longer-term**, Canada must recognize that the importance of highly skilled human resources to economic prosperity, coupled with demographic changes and increased mobility of people across national boundaries suggests that international competition for attracting and maintaining a highly educated, skilled workforce will continue to intensify.

A shift in the attitude of Canadian business toward investing in human resource development is needed. In the past, human resources have been treated as a relatively free good by industry and investment has been seen as a public responsibility. In the future, with demographic shifts and declining growth in the labour force, technology induced demands for higher level skills and continuous upgrading, Canadian industry will have to take on a significantly greater responsibility for developing its workers.

Lack of attention to this issue by industry is reflected in government. At the federal level, the government directs enormous resources to post-secondary education and training for people outside the labour force. Most of the federal government's training resources target the long term unemployed and disadvantaged groups. Of a total budget for training and work experience of $3.4 billion, EIC devotes $400 million to working with the private sector on human resource development, the bulk of which is used to help employers train workers in skills designated as being in short supply.

In addition, it is increasingly recognized that the most productive results from the introduction of new technologies are obtained when production methods and work organization are modified and skills are upgraded. **Integrated** approaches to technology, management skills and human resource development are the key to success. The federal government has in place some excellent programming to address these issues but they are fragmented and dispersed. These include ISTC and International Trade activities directed at improving management skills, and the NRC's IRAP. EIC's Industrial Adjustment Service ($23 million) and the Human Resources Planning component ($17 million) of the Labour Force Development Strategy which will build on excellent sector initiatives that have been launched in the automotive repair and steel sectors would be appropriate candidates for integration with IRAP and ISTC technology diffusion activities.

Bringing elements of these programs together in a critical mass would provide a credible base from which the federal government can forge

partnerships with other departments, the provinces, colleges and universities, private sector associations and labour.

> ***Recommendation 12.*** ***That ISTC should examine the possibilities of establishing closer partnership arrangements with NRC/IRAP and Employment and Immigration Canada leading to the creation of more skill-building activities for young men and women.***

6.4 Technology

6.4.1 General Issues

Successful **technology investment is conditioned by many factors.** Most **SMEs lack resources** to deal with all these factors in acquiring best-practise technology, from either domestic or international sources.

Federal and provincial governments have responded with an array of programs and services, many planned and delivered in isolation from one another. With some notable regional exceptions, there is little overall coordination between programs and services at either the federal or provincial levels. This results in incomplete coverage, sub-optimal delivery and the need for SMEs to "shop around" for both technical and business assistance. There are no programs which in themselves offer a full array of technology and business services.

Undue preoccupation with solely the *domestic* science-technology base as a source of technologie for SMEs would represent a sub-optimum strategy for Canada in the face of the incipient shifting of the world technological balance overseas. Increased attention needs to be focused on *foreign* technological developments and their potential for import and adaptation to solve the needs of SMEs for technologies, and to stimulate technological innovation and increase productivity and competitiveness. Furthermore, scientific and technological intelligence gathering, particularly from overseas, needs to be increased and improved.

6.4.2 Role of government

The Task Force has identified some roles for government in enhancing the technological capabilities of firms. In general these are:

- promoting SME **awareness of importance of technology investment** to building competitive capacity.

- assisting SMEs to **seek out appropriate, best-practice technologies.**
- increasing and improving the **access to technologies** of both domestic and foreign origin.
- encouraging SMEs with common needs to **join efforts** in seeking technology-based solutions and answers

6.4.3 Current activities in Canada.

A current ISTC survey of federal and provincial activities in industrial technological support describing existing programs and services, shows the sub-optimal nature of most of the programs and reveals gaps in the overall coverage.

Industrial technology support in Canada is achieved principally through the activities of **National Research Council of Canada's Industrial Research Assistance Program (IRAP),** network which provides technology support through direct delivery of technological information and assistance to SMEs nation-wide. The network includes provincial research organizations, universities, colleges, centres of excellence and some parts of the private sector. The program is well-received by industry and is dedicated to serving the technological needs of SMEs in particular.

ISTC's innovation services in part determine and resolve technology problems focusing mainly on **business diagnostics, management awareness, and management skills.** Industry has responded well to these. In addition, the TOP program gives them access to a network of technical expertise. Federal departments are also active in developing and/or providing access to technology information systems or databases e.g., CISTI's Canadian on-line enquiry service (CAN/OLE), dISTCovery, BOSS, and CANMATE (a CMA service, although supported by ISTC and NRC).

Science-based Departments and Agencies (SBDAs) are active in seeking improved mechanisms for transfering technologies from laboratories, universities are seeking improved methods of interacting with industries, and provincial research organizations are becoming more dynamic in providing information and transferring technology. NSERC's Research Partnerships program includes a technology diffusion element.

Several activities/programs/services throughout Canada attempt to address the problem of **foreign technology** acquisition by SMEs. The NRC/IRAP program and network partners are directly engaged in request-initiated, offshore technology acquisition activities. This is carried out in close

collaboration with the **Technology Development Officer (TDO) network** of EAITC in posts overseas often employing the EAITC Technology Inflow Program (TIP). The Task Force has stressed that TIP needs to be strengthened.

Some provincial research organizations and ministries are engaging in international technology acquisition, (notably the province of Quebec), but only the wealthier provinces can afford to perform these activities.

Consulting firms tend to focus on the needs of larger companies who can afford to pay for the services.

6.4.4 Priorities for action

The Task Force consultations across the nation repeatedly stressed that industrial technology support programs and services should be dedicated to **industry-initiated, demand-driven, client-orientated activities** and, where possible, include delivery by private sector.

> *Recommendation 13. That holistic approaches should be taken to resolving the difficulties that firms have in acquiring and deploying appropriate technologies. In particular, there is a need to collaborate and cooperate more fully between existing technological and business-support programs and services.*

> *Recommendation 14. That the Industrial Research Assistance Program (IRAP) of NRC should be clearly recognized as the dominant industrial technological support and enhancement system and network in the nation and should be sustained, strengthened and adequately funded.*

The Technology Outreach Program (TOP) and its network of Technology Centres is viewed by the Task Force as another key instrument in increasing technology diffusion.

> *Recommendation 15. That the TOP program should be enhanced and further promoted, and continue to be linked effectively with the IRAP technology network.*

The recent TOP evaluation recommendations that TOP be performance-funded and that TOP become a "national network" in scope are supported by the Task Force.

It should be clearly recognized that it is not feasible for SMEs to build better "receptor capabilities" wholly by themselves. Information on emerging or new technologies, scientific and technological intelligence gathering, supporting technology brokerage, technology evaluation and assessment, and the determination of critical technologies were all issues which the Task Force felt could best be addressed by a strong supportive role by government. The Task Force felt that there is a need for products and services designed to bring about improved and increased SME receptor capacity and capabilities, i.e., aimed at **increasing awareness** of both potential for business development through technology investment, and alternative technologies themselves. The Technology Opportunity Showcases of ISTC are an example.

> ***Recommendation 16.*** *That ISTC and IRAP networks should jointly explore the possibilities of establishing a national technology clearing house for Canada so that both domestic and foreign technologies could be examined and banked for use upon demand by agencies, industry support organizations and firms requiring them.*

> ***Recommendation 17.*** *That scientific and technological intelligence gathering and dissemination should become an integral part of the work of the strategy. This could be accomplished in part by scientists and engineers in agencies throughout Canada as a formal part of their mission in attending scientific and technological conferences and workshops world-wide.*

6.4.5 Technology diffusion and the patent office

The Task Force felt that SMEs, assisted by the technology support network, could and should make better use of existing and enhanced scientific and technological information (STI) in nation-wide and international technological data bases by improving access to and utilization of STI by search and retrieval techniques and by selective dissemination of information mechanisms. In addition, it was felt that patents and patent information could be used more effectively.

Data bases on patents have been established by Consumer and Corporate Affairs as part of its responsibilities under the intellectual property statutes. Recent Patent Office promotional programs have encouraged the use of patent documents for generating new R&D ideas leading to the development of new products, and for avoiding duplication of existing research, among many other uses. To facilitate access to this information across the country, the government granted that department $74 million to computerize the Canadian patent files. The tendering process for the automation is well underway and the project should be completed by 1996.

This project should prove to be a useful tool for rapid technology diffusion: it has been estimated that about 80% of the information in electrical and mechanical engineering technology patent documents cannot be found in any other published work. Furthermore, patent information quickly becomes available once an application has been filed, while other sources of information may be subject to the publishing cycles of technical journals.

The importance of having ready access to information on technologies of potential value to firms was stressed by the Task Force. This in itself is viewed as being of somewhat limited value unless a corresponding effort is made to assess technologies for and on behalf of the many firms who do not have the in-house technological capacity at this time, particularly in the areas of critical technologies.

> ***Recommendation 18.*** *That efforts to increase the access to and utilization of patent information should be encouraged and supported.*
>
> ***Recommendation 19.*** *A plan should be developed to establish an institution, preferably within the private sector, with joint public/private support, to carry out technology assessments on an on-going basis, in critical areas of science and technology.*

6.4.6 Technology from international sources

The Task Force recognized that **international trade** was of paramount importance to the economic well-being of Canada and that trade in technologies should be an integral and increasingly more important component of these activities. The Task Force points out that future international trade agreements might attempt to strengthen efforts to increase the flow of technologies towards Canada through measures such as direct investment, international industrial collaborative activities, intellectual property management and movements of skilled people.

> ***Recommendation 20.*** *That international technology acquisition activities should be an integral component of a nation-wide domestic industrial support network and international technology acquisition activities throughout Canada should be promoted, developed and supported.*
>
> ***Recommendation 21.*** *That the Technology Inflow Program should be re-instated at an increased level of funding and the offshore Technology Development Officer network should be maintained and increased. Industry should be encouraged to engage more fully in international technology acquisition and ways should be sought to*

increase the number of private sector organizations involved in the activities.

6.5 The role of science-based departments and agencies.

6.5.1 Basic issues

The federal government spends approximately **$5.45 billion on S&T.** These expenditures in part fund approximately 200 federal laboratories across Canada, with activities in all regions. These labs employ approximately 33,000 people, who include many of Canada's top experts in most areas of science and technology. These laboratories will be increasingly recognized as potential sources of new technology and will then be able to strengthen their contribution to broad industry-dominated technology acquisition, development and diffusion processes.

6.5.2 Policies and procedures affecting technology diffusion.

An effort has been initiated to **update administrative policies and procedures,** to ensure that all of the federal S&T labs have the same strong incentives to provide leadership and cooperation to industry in securing best practice S&T in Canada.

6.5.3 Promoting S&T alliances

Science-Based Departments and Agencies (SBDAs) claim to be involved in several thousand S&T alliances, more than 75 percent of which involve at least one business partner. Approximately 60 percent of all business partners are SMEs. Alliances result in the creation of new technologies and help participants to gain access to strengths and capabilities they themselves do not have.

6.5.4 Priorities for development

It is evident that there is a need for the development of improved mechanisms pertaining to access to new **technologies in federal labs** and for actual technology transfers. Suggested items for consideration should include:

- "One-Stop Shopping" for assistance and information on available technologies;

- an inventory of technologies and expertise at federal labs and computerized access to Canadian patents;

- technology information systems, to help industry understand and evaluate new technologies from the labs, and the development of technology-specific business opportunity documents pertaining to new technologies.

Specific mechanisms for more **technology transfer** should include:

- the establishment of SBDA technology transfer offices
- an increase in the number of S&T alliances;
- clearer identification of Canada's technology transfer talent pool, i.e. an inventory of technology transfer help available in the SBDAs and other technological agencies and institutes;
- Prototype/Demonstration; financing the construction either of prototypes or of full scale demonstration models of various technologies for the labs; finance development and extension of these technologies to new end-uses;
- encouragement of technology brokering in the private sector; and
- an increase in and improved information on federal assistance programs.

6.5.5 Informatics development

The possibility of designing a **multi-departmental user-friendly database** that will allow queries on questions such as availability, criteria and purposes of industry-oriented programs; location, nature and access to S&T activities; contact points for expertise or further information, etc. should be considered. This information system should be broadly available and user-friendly. Information on the S&T activities, programs and capabilities of federal Science-Based Departments and Agencies (SBDAs) should be part of a broader "how to" business assistance and information system, which can direct users (particularly SMEs) in learning how and where to get specific help or more information on various questions such as financial management or technology licensing and acquisition. This of course would include many of the items outlined as priorities above and include as a key element "**The Road Map**", an interactive geographic data base, which displays Canada's S&T capabilities.

6.5.6 Priorities for action

Recommendation 22. *That the technology transfer endeavours of the SBDAs continue to be supported and that partnerships be strengthened between SBDAs and other organizations and networks in Canada that provide technology-related services to SMEs.*

Recommendation 23. *That ISTC should continue to work with the SBDAs to develop an appropriate and common "toolkit" aimed at increasing the SBDAs' supporting relationships with SMEs. This should be integrated with or complement, existing "toolkits" supporting technological development in SMEs.*

6.6 Universities and colleges

6.6.1 The issues

Universities and Colleges are major sources of highly-skilled, first-class scientists and engineers and of scientific and engineering knowledge much of which is relatively un-tapped by industry. There is a need to increase and improve industrial outreach capacity in universities and colleges. Despite the existence of university extension services and some successful industry liaison activities such as in the set up of spin-off firms or "science parks", the focus overall still appears to be on technology-push mechanisms and transferring research findings through dissemination processes.

6.6.2 Specific problems

According to consultations held with university officials and representatives of NSERC, problems identified by the academic community include:

- insufficient **cash-flow** on the part of firms to be able to invest in university research, especially in the early stages;
- lack of **skills in identification of technologies** with potential for exploitation, particularly expanding to broader applications, and shortfall on **marketing skills**;
- **patenting skills** (knowledge and funding for such activities is often short);
- development of technologies to the point where they become both **economically and technologically feasible** is often not carried out; and

- the **cultural gap** between universities and small businesses is often wide

6.6.3 What is being done?

Most universities throughout Canada have established technology transfer offices and activities. Some universities have instituted industrial technological assistance activities directly related to the needs of SMEs for technical assistance. Other universities and colleges are already an integral part of the IRAP Network and have IRAP Industry Technology Advisors attached to their technology transfer offices.

UBC has established a small prototype development centre which has a small amount of funds dedicated to this activity. Many universities which have technology transfer officers report, however, that although they have fairly good contacts within their community, they have great difficulty in establishing contacts with SMEs further afield.

NSERC has instituted several activities relating to industrial technological support, the Industrial Research Chairs in Canadian Universities program which is in part designed to exploit the special knowledge and expertise at Canadian universities for the benefit of industry; the University-Industry Co-operative R&D Activities; and the Technology Diffusion Activities program which focuses on fellowships, workshops, seminars and affiliations.

6.6.4 Priorities for action

The establishment of useful, well-functioning linkages between users (SMEs) and potential suppliers of technology (in this case the university or college communities) is the most critical part of any technology transfer process. Universities tend to be somewhat introspective or regional in their outreach activities and are thus hampered by the limiting size of the potential market for their technologies. SMEs on the other hand, often find it difficult to approach universities for technical help, and often feel obliged to look elsewhere. By doing so, both communities lose out.

The need for a nation-wide "marketing" capability on the one hand, combined with a need for industry-sensitive, technologically-skilled experts on the other would seem to point to the desirability of having more "IRAP-type" industry technology advisors (with concomitant business support from a national network) located within the universities, an integral part of that community and yet dedicated to serving the needs of SMEs.

Recommendation 24. That the mobilization of the intellectual capital resources of the more pragmatically-orientated departments within universities, such as Faculties of Engineering and Architecture, and/or the specialized departments such as Food Processing Sciences or Fisheries Technologies should be considered as a priority for action in Canada. Efforts should be made to ensure that Universities and Colleges throughout Canada become active nodes in a national industrial extension network incorporating both technological and business support. University departments such as Engineering should be specifically targetted for inclusion in the national IRAP network. This should be carried out incrementally over a short number of years.

If these exceptional resources are to be mobilized to benefit the maximum number of firms across Canada, then the resources should be linked firmly with the network that serves the biggest cross-section of the industrial community, namely IRAP.

7. THE DELIVERY INFRASTRUCTURE - A NATIONAL INDUSTRIAL TECHNOLOGY EXTENSION SYSTEM

One of the key strategic deliverables of this initiative is an industrial technology diffusion extension network, the primary purpose of which would be to support the solution of problems and the identification of opportunities by SMEs. This network, or system, is the primary vehicle through which government organizations and their private sector partners would interact with SMEs in delivering the ***Whole Enterprise Strategy.***

It is important to appreciate that SMEs are **unique entities which are undergoing constant change. The problems and opportunities associated with survival and growth vary from company to company** and solutions to impediments are usually complex and specific to a firm's given situation.

7.1 Delivery and networks

The effectiveness of any technology diffusion strategy is dependent upon the availability and flow of scientific and technological knowledge and know-how. Since the technology requirements of individual firms can be as unique as the firms themselves, the basic challenge becomes the delivery of **"problem-solving information".**

There does not appear to be a shortage in Canada of technological information, data bases, programs or services in the area of technology itself, although there are some gaps as outlined in earlier sections of this report. However, SMEs have encountered the frustrating problem, about which they complain continually, of having to engage in multi-layered shopping when searching for answers to technical and business problems. **The main problem therefore is one of access, coordination and service delivery.**

The overall concept of an extension network is not new. In Canada, IRAP has performed this function effectively in terms of support for technology *per se.* In Japan there is the Kohsetsushi, in Australia the National Industry Extension Service, in Germany the Fraunhofer Institutes with variations of the same basic idea being applied in other countries. The intent of all these systems is to facilitate access by SMEs to resources, expertise, information and other forms of support which it is not feasible for them to develop internally. The proposal below draws heavily on the experiences of established systems and attempts to avoid the pitfalls.

Canada currently has elements of a strong networking infrastructure in place. Existing networks include IRAP, ISTC Business Service Centres, the Association of Provincial Research Organizations, and various others, some of which operate at the regional level. Some of these are electronically based.

7.2 The extension system

The proposed delivery infrastructure of the strategy is a **National Industrial Technology Extension System.** The concept would build on **existing institutions, programs, services and networks** with a goal of delivering a coherent package of services in those key functional areas of the technology investment process, namely:

. Management
. Technology
. Human Resource Development
. Marketing
. Finance

The extension network would in effect, be a consolidation of existing networks, **which would be built, administered and delivered at the local/regional level,** capturing the good features and positive trends in activities in each region. Because the institutions, industries, strengths and needs vary from province to province, this regional tailoring is critical to the success of the system in meeting the needs of businesses. In addition, joint planning and strategy development will be required at both the regional/provincial and national levels.

Nodes in the regions would act as focal points for acquiring and disseminating information requested by SMEs. The nodes would, in general, rely both on their own resources "tool kits" and other institutions and auxiliary networks to deliver as complete a service to SMEs as possible. In any given region, the nodes could be:

. ISTC regional office
. IRAP Industry Technology Advisors
. Provincial Research Organization
. provincial government organizations
. universities and colleges
. federal government laboratories
. other federal government departments and agencies (e.g., FBDB, CEIC)
. technology centres
. business associations
. service industries (e.g. consultants, training organizations)

It is important to emphasize that **the officer(s) in each node would need to be highly trained.** Two optional approaches are available to operationalize this concept.

7.3 Option 1. From specialized service to full-service node

The principle behind this option is that a business client would be able to get, to some degree, a "complete business service" in any one of the nodes in the network. Thus, for example, each node officer would be trained and equipped with appropriate tools in business diagnosis and problem solving, and in the key technology-related services and programs available to businesses from public, private and academic sources. The node may deliver its own specialized services and programs, but would be capable of taking the whole enterprise approach in determining the real needs of the company and in making the contact with other sources of support on behalf of the company. Access to up-to-date electronic information would be **essential.**

For such a network to work efficiently, each node would have to agree to provide the full service and referrals. Cooperation, not competition, among agencies would drive it, with the interests of the client being paramount. The "carrots" to secure the necessary level of cooperation could include access to data bases, free training and the provision of tools such as diagnostic software.

Officers from all nodes would assemble once or twice a year for two to three days of compulsory training and optional seminars on specific topics. This networking activity would be essential for system strength.

To some extent, the diagnostic and referral services mentioned above are being provided by ISTC, IRAP and other officers. One disadvantage of the proposed approach is that it could dilute the focus and the expertise of successful organizations such as IRAP. With this in mind, a second option has been explored.

7.4 Option 2. A business counselling service

This option features one or more regional industrial counsellors (mentors) who would play the pivotal role in the extension network. The counsellors would generally, but not exclusively, be the primary points of contact for the SME. They would be unique, highly qualified individuals, possessing a good appreciation of the role of technology in business operations, but more importantly they would be particularly skilled in accessing both functional and electronic networks to identify solutions to

Nation-wide Industrial Extension System

Technology Investment of Firms

Policy and Strategy

Government Policy Framework

Network Nodes (integrated delivery system)

- *Federal Agencies*
- *Provincial Agencies*
- *Inter-national*
- *Private Sector*

Feedback

Delivery

to clients at local and regional levels:

* Management
* Marketing
* Technology
* Financing
* HRD

SME receptors across Canada

Sources of Technology

domestic and foreign

Delivery System

Regional and National Coordination

Portfolio Organizations + Partners + Provinces

Fig.I

National Industrial Technology Extension System

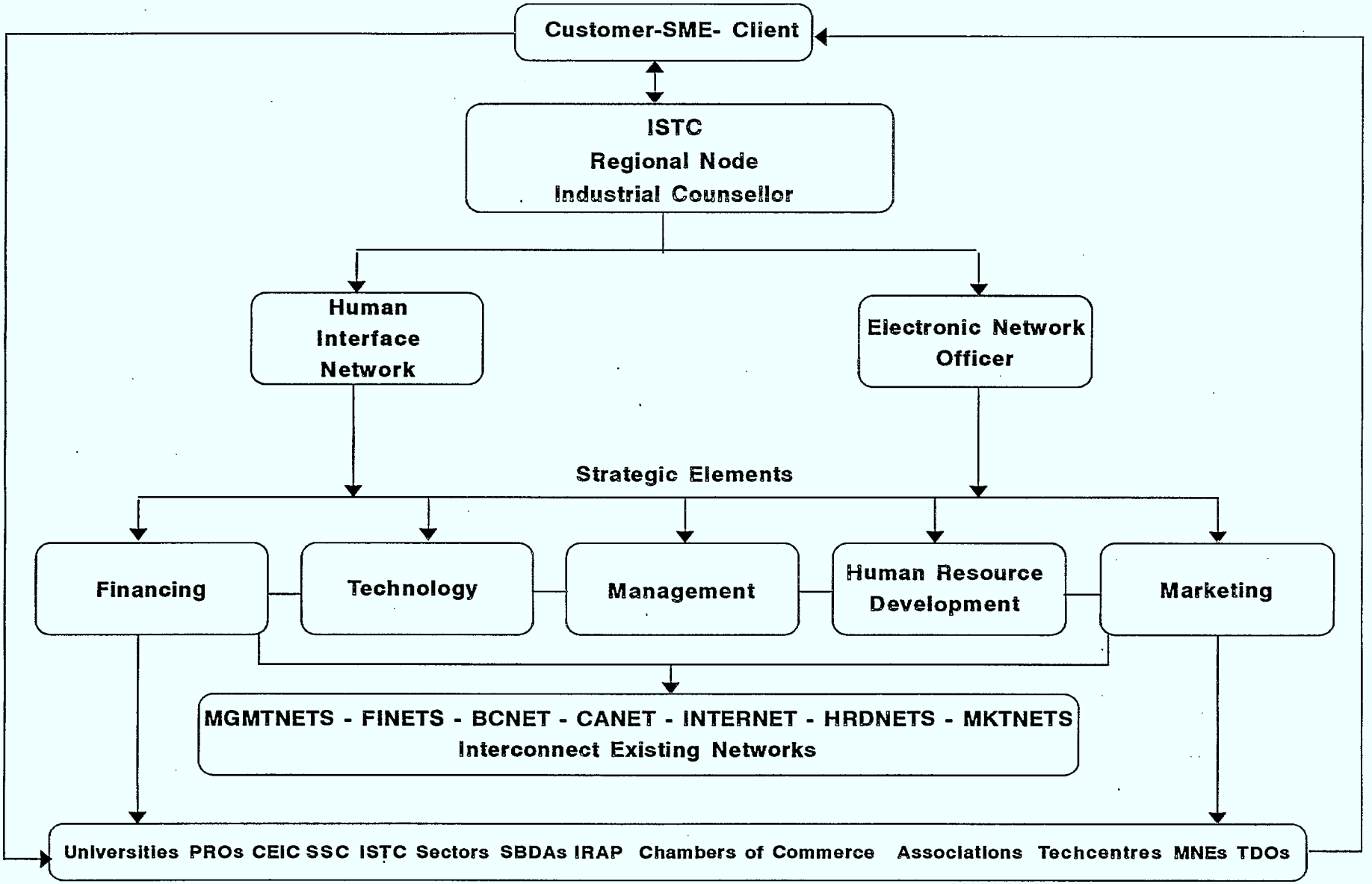


Fig II

problems. This concept is akin to the "hub and spoke" concept developed under the ISTC "one-stop shopping" project.

The second, and possibly the most important element in the network, is the government or contracted private sector contact who would act in effect as a **mentor** to the client. These persons would be the link between the customer/client and the problem resolving resources provided by the electronic network and its direct resource infrastructure.

The key to the success of this system would be the optimization of the linkage between the early identification of a client's problem and the utilization of electronic and other available sources of direct assistance. This option is not intended to duplicate or replace existing initiatives, but rather to provide a comprehensive analysis and set of solutions for the client to consider with respect to technology diffusion implications of his business. One of the current problems with the present approach to client problem solving is the attempt to adapt the problem to an existing solution (i.e. existing program).

The **Industrial Counsellor (mentor)** network would consist of two key elements: an **electronic network officer** who would have access to a range of data bases containing information on those areas of potential interest to a client, and a **human interface network** which would rely on the professional expertise and his personal network contacts.

It is envisioned that each regional or local office would have one or more dedicated **electronic network officers** who would possess advanced expertise analyzing and providing data as requested by the counsellors.

The role of the counsellor (mentor) would be to bring all the elements together to form a solution to a client's problem. This proposed role is not all that different from the present role being performed by regional officers, with the exception of the availability of a more extensive data and resource base, including greater time to work directly with clients and provide first-hand feedback to policy development officials.

Figure I depicts the concept of a nation-wide industrial technology extension system under either of the above options. At the centre of the system are the network nodes which provide the integrated delivery system. On the right hand side the network nodes are shown as linked to the SME customer/client who is the receptor of required support.

At the same time, and of equal importance, is the feedback loop which provides the network with information on those areas which are identified as being of prime concern and importance to the clients. This information can

then in turn, be used by policy and strategy organizations to address concerns identified by SMEs and the network. One opportunity to bring this forward would be in the periodic training sessions mentioned above.

Figure II provides a more explicit view of how the network might function under Option 2. The focus is on the SME client. The concept is designed to be both proactive and reactive. That is, the customer could approach a regional or local office, or a regional/local representative can visit, or offer to visit, a firm and provide information and advice on how the network might be useful in meeting the firm's unique technology related requirements.

7.5 Organizational considerations

The Task Force examined the problems inherent in the conflicting demands placed on officers, particularly in ISTC, who are trying to serve clients while fulfilling other internal corporate responsibilities such as ministerial support and committee work. One of the key factors in the success of business services is approachability, and the full commitment of the delivery organization to serving the client. Options need to be examined to separate client service from other corporate demands and to achieve better integration or cooperation at the planning and strategy levels among partner organizations.

It should be noted also that closeness to the customer can be achieved by contracting or delegating delivery to private sector organizations. In this regard, service industries play an important role.

7.6 Priorities for action

Recommendation 25. *That a national industrial technology extension system be established to reach out to firms all across Canada by building on what is in place, capitalizing on positive initiatives, and linking institutions and services together to form a coherent package.*

Recommendation 26. *That the system be built initially at the local and regional levels, as close to the customer as possible, including private sector service providers, and workshops be held in each province or region as appropriate within the next six to eight months to begin the building process.*

Recommendation 27. *That a feasibility analysis be undertaken of the establishment of the single system at the national level and of the direct linkages to posts abroad. This would include an analysis of the*

feasibility and costs of creating full electronic interconnection beginning with existing electronic networks and data bases.

Recommendation 28. That consultations with the provinces begin at the provincial level on ways to integrate federal and provincial activities into a mutual support system.

Recommendation 29. That support be given towards the development of service industries (e.g., consultants, training organizations) as key agents in the "close to the customer" delivery approach.

Recommendation 30. That options for managing and structuring the elements of the system be examined in order to promote a full commitment to the business client and integrate the planning, strategy and delivery operations of participating organizations more fully.

Recommendation 31. That research projects be designed and carriewd out to expand intelligence on methods of increasing utilization of technology by firms, recognizing that there are gaps in the current information on technology diffusion mechanisms.

8. IMPLEMENTATION PLAN

Implementation of a strategy that is as multi-faceted as this one involves many steps by many different players. Below the Task Force has outlined the principal steps only.

The first step is to obtain policy approval for the overall thrust. The conclusion of the prosperity consultations, the outcome of the portfolio review discussions, and the convergence of interest and specific initiatives in the area of technology diffusion all present an excellent opportunity for the federal government to take action in an area which reaches out to businesses and communities in all parts of Canada. The recommended implementation steps include the following.

- Establishment of a task team of Assistant Deptuy Ministers or equivalent from portfolio organizations to oversee the production of "umbrella" recommendations to Cabinet before the summer of 1992.

- Development of companion or follow-up MCs or Treasury Board submissions on specific initiatives, e.g., Innovation Services funding, IRAP funding, revitalization of TOP, Extension System development in cooperation with the provinces,etc.

- Steps to improve coordination and coherence in federal business policies affecting technology diffusion. A first step might be to organize a workshop of federal officials from relevant policy departments. This could be done in the fall of 1992.

- Establishment of partnerships with other stakeholders at the national and regional levels, e.g., SBDAs, provincial governments.

- Steps to accelerate and enhance the extension system-building process in each province or region. One way to do this would be by means of regional workshops involving key stakeholders and service providers. These could be held in the fall and winter of 1992-93.

- Launching of major studies on standards and regulations and on the feasibility and costs of full electronic networking of the extension system.

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ANNEX I. PROGRAMS, SERVICES and NETWORKS in OTHER COUNTRIES

The following is a brief and general overview of the major technology delivery mechanisms currently used by selected countries:

United Kingdom

The overall responsibility for overseeing the establishment and functioning of technology deliver mechanisms appears to be focused and distributed throughout the Department of Trade and Industry (DTI). In 1988 the department was reorganized and has become known as the "Department for Enterprise". The emphasis of this department has changed from being basically an industry granting agency to being very proactive in providing and supporting a range of services to help industry help itself. The primary elements of the Enterprise Initiative are:

- Consultancy Initiative;
- Marketing Initiative;
- Manufacturing Systems and Quality Initiative;
- Design Initiative;
- Business Planning Initiative;
- Financial and Information Systems Initiative;
- Research and Technology Grants Initiative;
- Regional Enterprise Grants Initiative.

In addition, DTI provides funds (transfer payments) to Wales, Scotland and Northern Ireland for technology development and diffusion initiatives, however the actual planning, administration and delivery of the initiatives is the responsibility of the individual regions. DTI is also responsible for the funding of various national research laboratories, but is actively investigating means of privatizing them.

The British Technology Group (BTG), one of the UK's primary technology transfer and diffusion organizations, is currently being offered to the private sector by DTI. In addition DTI provides financial support and varying degrees of direct involvement, to a wide range of institutions projects and initiatives i.e., regional technology centres, laboratory clubs, research associations, standards setting organizations, science parks and an array of specific industry support schemes. It is important to note that it is the policy of the department to have the delivery of initiatives carried out by the private sector or arms length organizations, insofar as possible.

Germany

In Germany, the focal point of S&T policy and the overall funding of R&D rests with the Ministry of Research and Technology (BMFT). BMFT controls the distribution of about 90% of the government's R&D funding. It has three basic responsibilities; the promotion of individual projects, financing National Research Centres and autonomous institutions (Max Plank and FhG) and the management of Germany's international interests.

The key element of the technology extension/diffusion mechanism in Germany is the network of Fraunhofer Institutes (FhGs). The primary role of these Institutes is to encourage German companies to introduce new technologies into their products and processes (over 60% of their funding comes from user fees). Prior to unification, Germany was spending about $500 million a year on outreach projects primarily through 38 FhGs, subsequent to unification an additional 19 Institutes have been opened up in the east at a cost of about $300 million.

In addition to the FhGs Germany has an extensive network of about 50 Max Plank Institutes which do basic R&D and receive funds from both the federal and Lander governments. Universities are funded by the Lander and German Research Association (DFG) which is in turn funded by the Lander and federal governments.

Again a trend can be noted whereby the federal government plays a coordinating role, and the actual technology development and diffusion mechanisms are delegated to arms-length organizations.

Japan

Japan has a somewhat unique government/industry relationship relative to other countries, in that it is much more co-operative, reciprocal and long term in orientation. This relationship facilitates mechanisms for the development, transfer and diffusion of technologies. The key organizations involved in the formulation and direction of S&T policy direction are The Science and Technology Agency (STA), The Ministry of Science Education and Culture and the Ministry of International Trade and Industry (MITI). Both MITI and STA are involved in long range forecasting, which in turn provides industry with guidance as to where it should be concentrating its resources with respect to technology acquisition and diffusion.

In order to stimulate the acquisition, adoption, adaption and integration of technology, particularly in SMEs, there exists in Japan a network of technological extension centres called Kohsetsushi. There are about

172 centres located in nearly every prefecture with a cumulative annual budget of $606 million. The cost of operating these centres comes from MITI, user fees and local governments, who pick-up most of the cost. It would appear that the "Japan Information Centre for Science and Technology", which has 18 centres in the regions which are linked to 187 local Technical Centres are one in the same as the Kohsetsushi.

The centres have a staff of about 7,000 professionals who provide technological assistance in about 475,000 cases (1988). Technical advisory teams were sent to assist companies on 72,500 cases. In addition, centres provided testing and analysis services in nearly 1 million cases and SMEs used centres' facilities in over 60,000 cases. The centres maintain a list of 4,000 consultants to augment its staff of 7,000.

Once again, the foregoing model highlights the trend for the federal level of government to concern itself with the "big picture" and delegate the actual delivery of technology related mechanisms to experts directly involved in decision making at the firm level.

United States

Unlike the foregoing countries, the US does not have, nor is it likely to have in the near future, a comprehensive policy on S&T. In fact, this topic has caused heated debate at senior levels of government.

With respect to technology delivery mechanisms at the federal level, there appears to be a trend that the Department of Commerce is taking a more proactive role through the National Institute of Standards and Technology (NIST) in promoting new technology diffusion initiatives. The State Technology Extension Program (STEP) is one of four new programs assigned to NIST under the provisions of the Omnibus Trade and Competitiveness Act of 1988. The objective of STEP is to provide technical assistance to state technology programs throughout the US, in order to help those programs help business and enhance their competitiveness through science and technology. NIST has also created a program to help SME manufacturers become more competitive through a program called Regional Manufacturing Technology Centers. DoC has created a program called the Advanced Technology Program which provides R&D grants to firms or consortia firms on a cost shared basis.

In addition to the above, there is the multi-department Small Business Innovation Research Programs (SBIRs) through which departments solicit proposals from SMEs for innovative solutions to the R&D priorities of the department.

A program of major importance in the networking and diffusion of technology is the DoD Defense Advanced Research Projects Agency which contracts in excess of $1.2 billion annually to promote research and technology development.

Notwithstanding the foregoing federal initiatives, the main activity with respect to technology delivery and diffusion is at the state level. In 1990 there were over 200 programs at the state level designed to promote economic growth with a majority of these containing a technology enhancement element. In 1988, 43 out of the 50 states had at least one program to encourage technology innovation and had collectively allocated over $550 million.

In summary, the US has an extensive array of delivery mechanisms, however the networking of these mechanisms is not at present well coordinated. Nevertheless there does appear to be a trend for NIST to be moving in this direction.

Trends in Other Countries

Sweden

Sweden has traditionally relied on three organizations to promote and deliver technology support programs to industry namely:

. The National Industrial Board (SIND)

. The National Swedish Board for Technical Development (STU)

. The National Energy Administration

It is understood however, that a new agency (no name yet) has been created recently to deal with S&T policies and their implementation **and** that this new organization will be consolidating many of the activities of the above agencies. Also a $1 billion Parliamentary Bill is being considered to strengthen the technology infrastructure. Again it would appear that centralizing networking activities are under way.

Australia

Approximately three years ago, Australia recognized that it had a problem with respect to the diffusion and networking of technology through out the country. To address this problem Australia introduced the National Industrial Extension Network (NIES). The mission of NIES is to help Australian enterprise attain and sustain international competitiveness through the focusing of ideas on enterprise networks. This has been achieved through the development of networks and information advisory services. The NIES program is a partnership between State and Commonwealth Governments. The services are directed at promoting and sustaining enterprise improvement. An information service has been developed to enhance one-stop-shopping and private sector consulting services and expertise has been developed and is available to industry to assist with change. In 1988/89 expenditures by governments on the network totalled about $60 million with about 70% of the funds coming from the States.

Denmark

Based on lessons learned from the Italians, Denmark appears to be one of the first countries to apply these initiatives to its entire manufacturing sector. The results appear to be extremely encouraging since in less than 18 months after the announcement of a national effort more than 3,000 of Denmark's 7,300 manufacturing companies were actively involved in the networks. The Ministry of Industry has stated that networking has taken on a life of its own, and no longer requires government leadership.

ANNEX II. STANDARDS AND REGULATIONS

Problem

It is generally agreed, that standards and regulations are becoming increasingly important in the enhancement of the international competitive position of industrially developed countries. Although technology and the diffusion of technology, are in many cases directly related to the standard and regulation-setting process, the complex interrelationship between standards and regulations and technology diffusion is not well understood. How do standards and regulations enhance or hinder the diffusion of technology? The basic issue to be addressed is to determine what is known about the role of standards and regulations in the technology diffusion process, identify the information gaps and propose specific initiatives to resolve barriers.

Role of government

The primary role of government is to create and enforce standards which directly impact on the public interest such as health, safety and the economy. In addition, the government is responsible for funding and participating on industrial standard-setting organizations. Through its extensive procurement activities the government also promotes standard-setting activities which are socially beneficial to creating industrial infrastructure. The areas of science and technology are promoted by government through the establishment of demanding standards in areas such as defence, transportation, environment etc. The government is also responsible for representing Canadian interests in the international standard-setting forum i.e., GATT, FTA, NAFTA.

Current activities

The basic infrastructure for the setting and enforcing of standards is essentially in place. The emphasis however, is on domestic consumer protection and regulation, with much less emphasis on the economic/industrial competitiveness issues. It is encouraging to note that in the most recent budget the government is undertaking to review its regulatory processes by systematically reviewing the regulating practices of several key departments.

Priorities and proposals

With respect to the interrelationship between standards/regulations and technology diffusion, the primary priority will be to determine what has been done, what is being done and what should be done to enhance the use of standards and regulations to stimulate the diffusion of technology. In order to achieve this, ISTC will initiate a comprehensive collaborative study. This study will not only investigate the diffusion issue, but will look into a range of related issues which are of specific interest to participating organizations. A detailed phased statement of work has been prepared and includes some of the following activities.

Outline of work plan

The primary issue to be investigated is the determination of the situation within Canada with respect to the interrelationship of S&Rs, technological innovation and international competitiveness. An important aspect of the project will be to allow for inputs and suggestions of other interested parties and to obtain innovative proposals from the private sector for the collection and analysis of information. In view of this, the statement of work has been developed in very broad terms in order to allow maximum flexibility in the preparation of proposals.

The issue, in its simplest form, can be stated:

IS THERE A PROBLEM?

- what is known, what is not known?
- what should be retained or modified?
- what new on improved structures are needed?
- what resources are required to implement change?

In order to carry out a comprehensive investigation of these issues and other related issues ISTC, in technical and financial collaboration with other interested departments and agencies, is proposing to under take the management of a multi-phase study. The focus of the study will be on investigating the role that S&Rs play in the technological innovation process and how they impact the international competitiveness of Canadian firms.

Scope of project

It is appreciated that any investigation on standards and regulations and their impact on economic and technological competitiveness will have to be carefully planned if it is to be completed within a reasonable time frame and in

budget. The final project report will be expected to present an overview of the S&Rs/technology situation including an analysis of problems and solutions in a clear succinct manner. Proposals will have to demonstrate what can be achieved and how it will be achieved. The following project phases are intended to provide the contractors with a basis understanding the key issues which should be addressed in the submission of proposals.

Phase I

Preliminary Investigation An overview of the Canadian situation. What structures and infrastructure are in place? How effectively do they interface and perform their roles? This investigation should include both voluntary and non-voluntary standards and regulations.

Phase II

International Situation What are the current international practices in standard and regulation-setting and what are the future trends and how do they relate to the Canadian situation?. What is the international situation with respect to S&Rs and technological innovation?

Phase III

Common Denominators What factors are, or need to be, taken into consideration to determine if the introduction of standards or regulations will ultimately enhance or hinder technological innovation and international competitiveness? How are these factors determined and how do they interrelate?

Phase IV

Further Action This phase will analyze and integrate the findings from the phases I, II, III. It will provide an overview of the current situation, including specific recommendations for future action and a detailed implementation plan.

Items for an expanded statement of work

Data collection

The contractor would be expected to be knowledgeable in identifying, collating and analyzing data from a wide range of sources. Sources of information would include government, industry and international historic and current data. The contractor would have to demonstrate that it or its agents

are fully capable of collecting all the relevant information and providing a comprehensive analysis of the data.

International assessment

The contractor(s) will have to demonstrate that it has the resources to meet the requirements of this task. The contractor will not only have to have access to a literature network, but more importantly interpersonal linkages with key policy organizations in various countries. This phase, in addition to providing insight into international initiatives, will be expected to show the relative position of Canadian companies with respect to their competitors in the areas of technology diffusion and adaptation. Policy trends and negotiating strategies of other countries will have to be addressed from the technological innovation perspective, particularly in the case of the European Community, NAFTA, FTA and GATT.

Common denominators

This is perhaps the most difficult area to develop and should possibly be carried out concurrently with phase I. The questions to be addressed in this section are first of all what is meant and understood by a voluntary standard, a non-voluntary standard and various types of regulations? What is the relationship of these factors and what are their common denominators? How do they interrelate internationally and most importantly, how should they relate nationally? The bottom line to this phase of the study is to show how S&Rs enhance and/or hinder the diffusion of technological innovation.

Further action

It is expected that this section will, based on the findings of the other three phases, provide guidance and recommendations on how Canada can best position and structure its self to cope with increasing international pressures. It should explicitly state what is wrong (if anything) with the current situation in Canada, and provide pithy recommendations on how and what is required to strengthen the Canadian position. It is expected that this section will take into consideration current government initiatives to streamline regulatory processes.

ANNEX III TASK FORCE ON TECHNOLOGY DIFFUSION STRATEGY

TERMS OF REFERENCE

Background

1. On 7th May 1991, Policy Management Committee considered a presentation from Policy Sector on technology diffusion. The objectives of the proposed Technology Diffusion Strategy were:

- to obtain a balance in overall S&T policy between creation and management and use;
- to address issues influencing the demand for technologies by SMEs;
- to develop an integrated approach to technological investment processes, determinants and policies;
- to strengthen the system of diffusing technology through activities, partnerships and linkages, and to maintain a national unity theme throughout;
- to support, enhance and market good existing activities;
- to launch initiatives to address deficiencies in the system; and
- to endeavour to upgrade the technological capabilities in many firms.

2. The committee reviewed the proposal and re-affirmed that the principal tasks in developing the strategy were:

- identification of "success factors" at the level of the firm that influence investments in technological capability;
- identification of the role of government with respect to these factors;
- description of existing policies, programs, services and networks related to these factors;
- identification of deficiencies in policies, services and/or programs which could be addressed in the short-term;

- identification of deficiencies in the system which could be addressed in the long term;

- presentation of a long-term implementation plan for the department's role in this area in relation to its major partners.

The committee acknowledged that from work carried out to date, substantial intelligence had been accumulated in all of the areas identified above. The committee recommended that, building upon this existing body of knowledge, a Task Force be established to complete input on specific items. These are outlined in 3. below.

3. Deliverables

The main tasks to be undertaken by the Task Force involve aspects of the Technology Diffusion Strategy outlined in 2 above.

The Task Force shall complete the following tasks by 30 September 1991, and present its findings to Policy Management Committee.

a) Specify in detail the factors and hierarchical nature of activities, (taxonomy of technology transfer mechanisms and levels of technological capability in SMEs), necessary for the successful acquisition of technologies by firms in Canada;

b) Define specific roles and priorities for government in assisting companies ultimately to achieve successful technology acquisition against each of the factors identified in a) above;

c) Fill in any remaining information gaps on what ISTC and its federal, provincial and other partners are already doing in relation to these roles.

d) Identify and describe a small number of initiatives which could be announced and undertaken in the short-term to remedy deficiencies or shortcomings in the overall national technology support system; this could include significant extension or enhancement of current activities.

The Task Force shall complete the following tasks by 15 January 1992 and present its findings to Policy Management Committee.

e) Produce a detailed action plan for strengthening or enhancing the array of services available to SMEs in Canada with a view to the delivery of

these services in a coordinated manner by both private and public sectors, at both national and regional levels, and taking full account of the outcome of the nation-wide consultations on prosperity. The action plan should include decisions arising out of a)-d) above and additionally offer specific:

- proposals for a phased strategy including targeting, piloting and an assessment of resource implications;
- options to strengthen and improve SME technology awareness, and assessment and evaluation of technologies;
- proposals to fortify international networking;
- proposals on workshops for national network building;
- proposals for ISTC's advocacy activities on key policy issues affecting technology diffusion;
- proposals for the Department's priorities and slate of activities in the area of technology-related management issues; and
- proposals for building the private sector's capabilities to deliver selected services

4. Membership

The Task Force will comprise Directors and Directors-General from ISTC and its major partners, namely NRC and International Trade, up to a maximum of ten members.

The Task Force will include representatives from ISTC.

- Policy Sector
- Science Sector
- Industry, Technology and Regional Operations Sector
- Capital Goods and Service Industries Sector
- Regional Offices

Initial chairmanship of the Task Force will be provided by the Technology Policy Branch of the Policy Sector of ISTC.

Administrative considerations for the Task Force will be the responsibility of the Technology Policy Branch of the Policy Sector of ISTC. Financial requirements should be minimal and will be funded from existing budgets within the Technology Policy Branch.

ANNEX IV. TASK FORCE MEMBERSHIP LIST

Graham Taylor (Chair)
Director, Technological Innovation and Diffusion
Science and Technology Sector
ISTC

John Jaffray (Secretary)
Special Advisor, Technological Innovation and Diffusion
Science and Technology Sector
ISTC

Rainer Andersen
Executive Director,
Manitoba Regional Office, Winnipeg
ISTC

Alan Anderson
Director, Regional Development, Technology & Investment
Industry Development & Technology
Ontario Regional Office, Toronto
ISTC

Brian Anderson
Director, Policy, Planning & Corporate Services
B.C. Regional Office, Vancouver
ISTC

Victor Bradley
Deputy Director, S&T Division
EAITC

Rick Chiasson
Commerce Officer
Light Vehicles Directorate
Automotive, Urban Transit and Rail Branch
Capital Goods & Service Industry Sector
ISTC

Bill Coderre
Senior Advisor, NABST Secretariat
Science and Technology Sector
ISTC

Denys Cooper
Head, Technology Assessment and National Coordination Group
Industrial Research Assistance Program
NRC

David Ellis
Provincial Coordinator, Quebec
Industrial Research Assistance Program
Montreal
NRC

Susan Gardiner
Deputy Director, Investment and Export Program
TPE
EAITC

Mike Kelly
Director, Investment Promotion
Investment Canada

Victor Landry
Director, Technology & Investment Development
New Brunswick Regional Office, Moncton
ISTC

Martin Mudde
Manager, Extension Services
Information Technologies Industry Branch
ISTC

Robert Noel
Director, Transportation, Aeronautical & Defense Industries
Quebec Regional Office, Montreal
ISTC

Elizabeth Payne
Director, Technology Outreach Directorate
Services to Business Branch
Industry, Technology and Regional Operations Sector
ISTC

Russell Roberts
Director, Industrial Innovation Policy Coordination
Industrial Competitiveness Branch
Policy Sector
ISTC

Pat Sampson
Director, Technology Applications,
Information Technologies Industry Branch
Industry, Technology and Regional Operations Sector
ISTC

Bob Smith
Director
Innovation Services Development
Services to Business
ISTC

Bill Smith
Director
Corporate Planning and Evaluation
NRC

Barry Sterparn
Director, Federal Research
Science and Technology Sector
ISTC

Alan Watt
Director, Advanced Manufacturing Technology
Industrial and Electrical Equipment and Technology
ISTC

ANNEX V. GOVERNMENT PROGRAMS AND SERVICES IN SUPPORT OF TECHNOLOGY DIFFUSION

Background

Government programs and services can assist in the process of diffusion of technology in various ways, although most of the programs themselves are not always designed with the diffusion of technology as their primary purpose. They more frequently reflect the mandate of the sponsoring department and as such are frequently limited in terms of sectoral and regional applicability. With a few notable exceptions, no one program addresses the broad topic of technology diffusion.

However, many programs lend themselves to some aspect of technology diffusion and the purpose of the following analysis is:

- to identify those programs contributing to technology diffusion;
- to identify where those programs meet the objectives of SMEs in technology diffusion; and
- to identify broadly, strengths and weaknesses among the array of programs and services that relate to technology diffusion.

Data Collection

The Department of Supply and Services "Guide to Federal Programs and Services" for 1991 was used as the initial survey document. There were over 1000 federal government programs, practices and services in place at the time the review was begun. Of these, 73 were identified as contributing to technology diffusion. These were entered into the table entitled "TECHNOLOGY SUPPORT: FEDERAL PROGRAMS and SERVICES". In addition to the guide, there were consultations within ISTC and with other government departments to acquire information about programs and services with a role to play in technology diffusion. Information is being gathered in a similar way on provincial programs through the Regional offices and other sources.

Format

This table's format employs headings which describe the objectives of small and medium-size firms (SMEs) in their pursuit of technology. There are three broad headings reflecting the general level of technological sophistication of the firm.

These are: "TURN ON TO TECHNOLOGY", the least sophisticated level, "OPTIONS IN TECHNOLOGY", the intermediate level of sophistication and "HIGHER CAPABILITIES", the upper end of technological sophistication. Each of the broad headings is in turn broken down into three sub-headings which represent the individual objectives.

Under the first heading, "TURN ON TO TECHNOLOGY", the three sub-headings are "ASSISTANCE" in acquiring technology, "INFORMATION" about technology and "AWARENESS" of technology. Under the second heading, "OPTIONS IN TECHNOLOGY", the three sub-headings are "SOURCING" of technology, "EVALUATION" of technology and "ACQUISITION" of technology. Under the third heading "HIGHER CAPABILITIES", the three sub-headings are "ADOPTION" of technology, "ADAPTATION" of technology and "INNOVATION".

As various programs are reviewed, an "X" is placed in the appropriate cell or cells of the table to indicate how the program supports the technology objectives of the SMEs. This is, of course, something of a judgement call since this exercise is not intended to evaluate either the scope or impact of the numerous programs listed. It should be noted that this tabular format is not meant to be either exhaustive nor quantitatively rigorous. It is intended to be descriptive only. The resulting table, however, does give an indication of where federal government programs lend support to technology diffusion. An additional, companion table, contains the same list of programs with some accompanying comments to make qualitative distinctions among the programs.

Analysis

The following table summarizes the number of programs which lend support to each SMEs objective. There are 73 programs included in this review.

SUMMARY OF FEDERAL PROGRAM SUPPORT FOR SMEs OBJECTIVES

OBJECTIVE:		**# PROGRAMS:**
"Turn on to Technology"		(40% of total programs)
Assistance	09	(12% " " ")
Information	49	(67% " " ")
Awareness	29	(40% " " ")

"Options in Technology"		(27% " " ")
Sourcing	24	(33% " " ")
Evaluation	15	(21% " " ")
Acquisition	20	(27% " " ")
"Higher Capabilities"		(30% " " ")
Adoption	20	(27% " " ")
Adaptation	21	(29% " " ")
Innovation	24	(33% " " ")

Using the same approach, the three broader objective headings, ("Turn on", "Options" and "Higher Capabilities") can be weighted and summarized as well. There were 87 (9+49+29=87) out of a possible 219 (73 x 3= 219) occurrences, or 40%, where programs could have supported the three objectives under the first broad heading, "Turn On to Technology". Similarly, there were 59 occurrences, or 27% under "Options in Technology" and 65 occurrences, or 30% under "Higher Capabilities".

Analysis

This analysis is not intended to measure the effectiveness of these programs in meeting the objectives they support, nor does it tell us whether the impact or scope of any given program is sufficiently large to make an appreciable contribution towards technology diffusion in a given sector or region. Therefore, the statistical summary is only indicative, but not necessarily statistically significant according to the laws of statistical analysis.

What this analysis does indicate is where there are instances of relative strengths and weaknesses in support for technology diffusion, objective by objective.

From the above summary table, a picture of government support for technology diffusion, as expressed in terms of the objectives of SMEs, begins to emerge. It is also seen that there are limitations in the support offered by most of the programs, arising from sectoral and/or regional constraints, to say nothing of the constraints on the limits of financial support or duration of the life of programs.

The most striking observations are, first, the lack of support for "assistance" in the early stages (12%) and, second, the considerable amount of support through provision of "information" (67%). Most of the other objectives receive between 21% and 40% support across the range of programs included in the review.

The amount of funds available under the programs reviewed runs into hundreds of millions of dollars, annually. IRAP alone had funding of $85 million in fiscal year 90/91. As noted above, the thrust of each of the many programs subsumed under this review is not exclusively dedicated to technology diffusion; therefore the amount of funding made available by these programs cannot be said to contribute totally towards technology diffusion. In a period of government policy of fiscal restraint, funded programs will remain an important and much sought after means of promoting technology diffusion. However, it will become progressively more difficult to obtain increased resources for funded programs.

In terms of the needs of SMEs, they would benefit from more program support in the areas of management skills, the management of technology, training and in the areas of the enhancement of business culture and climate. We still need to know roughly what proportion of SMEs fall into the early, middle or advanced stage of their technological evolution and what it will take to move them to the next stage.

REVIEW OF PROVINCIAL PROGRAMS BY REGION

Introduction

Provincial programs with elements contributing to technology diffusion were reported in tables analogous to federal programs, and analyzed on the same criteria. The results for Maritime provinces and the western provinces were each summarized for reporting purposes as some of the provinces did not have enough program activity for a meaningful analysis.

Maritimes

This region of the country has the smallest proportion of the population and this is reflected in their proportion of national industrial R&D personnel. The Maritimes has the smallest number of provincial programs, fifteen, of any region and they tend to be focused on the early stages of technology development. The programs tend to reflect the sectoral makeup of the region with the emphasis on the fishery, food products and oil and gas exploration. There are general support programs as well. ACOA's programs are considered in this review.

This region is one which could probably benefit the most from increased program support for technology diffusion. Such increased support would be highly visible but a question remains as to whether an impact commensurate with the increase in support without corresponding

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This region is one which could probably benefit the most from increased program support for technology diffusion. Such increased support would be highly visible but a question remains as to whether an impact commensurate with the increase in support without corresponding

improvements in local infrastructure, management attitudes, work force skills base, overall technology culture and general economic climate.

Quebec

Quebec has taken a unique approach to program support for technology diffusion, specifically and technology in general. It has employed by far the largest number (123 programs) of programs of the regions. These programs are highly specific, sectorally, regionally and in some cases, both sectorally within a region. Quebec has the second largest number of industrial R&D personnel of the four regions and, proportionally, fewer than Ontario, which has the largest.

There is an emphasis on the higher stages of technological development among Quebec programs, although there is broad support across all SMEs objectives. Strongest support is for "evaluation", which is an indication of the relatively high level of technological sophistication in the province. Support is weakest for the "assistance" objective.

Much of Quebec's program support relates to the institutions of it's technological infrastructure, such as AQVIR, CRIQ, CRIM, and several others. Some of the sectors towards which support is directed are hydroelectricity, natural gas equipment, transportation, environmental industries and agriculture. Within agricultural programs, there are further regional dimensions as well. In addition to the large number of provincial programs noted, Quebec also receives specific program support from the Federal Office of Regional Development (FORD-Q).

Quebec has recently begun economic initiatives which subscribe to Dr. Michael Porter's theory of industry clusters as a means to enhance international competitiveness. This will provide an interesting climate in which to observe technology development in Quebec.

Ontario

Ontario has the largest share of the population and a disproportionally high share of industrial R&D personnel. It has the second largest number of programs (52) of the four regions. Ontario's programs show slightly more support for SMEs objectives in the middle and higher stages of technological development, although there is fairly even support across most areas. As with the federal programs and Quebec, support is weakest for "assistance". (The fact that three regions all indicate low support for the "assistance" objective of SMEs may answer, in part, why SMEs are slow to start the process of technology uptake).

In contrast to Quebec's approach employing a large number of highly specific programs, Ontario's approach is to have fewer programs with broader applicability. The focus of these programs is on manufacturing, small business, exports, construction, tourism, training and the environment.

Although Ontario is the leading region in terms of technological advancement, it too is suffering in the current economic environment. The positive impact of programs on technology diffusion is being undermined by these economic conditions.

The West

The West is the most diverse, geographically, economically and culturally, of the four regions under discussion. It is third largest in terms of population, industrial R&D personnel and number of programs (37). Unlike Quebec, Ontario and federal programs, western programs are highest in support for "assistance". Like Ontario, it is lowest in support for "awareness". In the other SMEs objectives, support is fairly evenly distributed.

Some of Manitoba's programs are sector specific, with the emphasis on agriculture, advanced industrial materials and biotechnology; others are general. B.C.'s programs clearly have a more scientific focus, looking at such things as S&T, R&D assessment, science, student support, scientist support and engineering support. Alberta and Saskatchewan have smaller numbers of programs which have a general orientation.