Industry, Science and Technology Canada
Industrie, Sciences et Technologie Canada

The Human Dimension of Competitiveness

Canada

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Preface

The basis for competitive excellence in the world economy has been changing radically over the past two decades. We are moving rapidly to an environment where the ability to use knowledge and information in creative ways is becoming the key determinant of success in the marketplace. For many Canadian firms at the forefront of this new revolution, the major raw material is knowledge and the major investment is in the people who use that knowledge, rather than in plants and machinery.

Many industrial clients of Industry, Science and Technology Canada (ISTC) are now convinced that the key to their future success lies in the quality of their employees and the creative ways in which they manage their activities. Not surprisingly, this new awareness is causing industry to examine closely the country's approach to the education and training of its work force and, indeed, its own approaches to promoting innovative behaviour among managers and employees. In the process, industry is looking to this department to provide some leadership on these issues.

This report is intended to form the basis for discussion with interested parties in the private sector, academic circles and government departments that share ISTC's objectives of scientific excellence and international competitiveness in Canadian industry.

1. Introduction

The most dramatic change occurring in the world economy today is the transition from the traditional smokestack economy of the past century to an economy dominated by information-intensive enterprises, particularly those whose raw material is knowledge and whose major capital investment is people. The driving force behind this transition is the increasingly rapid pace of technological innovation. Success in this new international trading environment will require a work force both comfortable with, and skilled in, the new technologies and management skilled in combining technical and human resources to bring about innovation.

Employment and Immigration Canada has the federal lead role in training issues, but ISTC has an important role to play as a catalyst for innovative improvements in the quality of Canada's human resources and in helping industry clients become more technologically advanced and, ultimately, more competitive.

This report identifies four human resource development categories that have a direct impact on the ability of Canadian industries to be competitive and that will be important for public debate in the future: management and entrepreneurship training, labour force training, post-secondary education and the responsiveness of the educational system to the needs of industry. In Section 3, these categories are analyzed in terms of specific issues and priorities important to ISTC clients.

2. The Importance of Human Resource Development to the ISTC Mandate

In its 1987 study *Making Technology Work, Innovation and Jobs in Canada*, the Economic Council of Canada points out that technological change is crucial to economic advancement. It is the key to improvements in productivity, global competitiveness and, ultimately, employment. Rapid adoption of appropriate new technologies is therefore vitally important to future prosperity. New technologies by themselves, however, are not enough. A well-trained, flexible and committed work force is equally important to the future prosperity of the Canadian economy.

The quality of Canada's human resources will continue to depend on the ability of the educational system to respond to the needs of a new technology-driven economy, new types of skills training and retraining approaches that support a life-long learning process, and innovative management practices. Perhaps the Economic Council summarizes the core issue most succinctly:

"Education is a cornerstone. Its importance in a high-technology world cannot be ignored because the accelerating pace of change will lead to rapid obsolescence of skills. The education system therefore faces a profound challenge. It must prepare individuals to be mobile, flexible, adaptable, and versatile. The ability to learn will be the premium skill of the future. The traditional sequence of formal schooling, on-the-job training, and lifetime practice of one's trade or profession is already being superseded by a more cyclical pattern in which periods of reschooling and retraining feature prominently." (p. 30)

The educational system, however, is not the only candidate for change. Canadian management has an equally significant task ahead. The Economic Council report also expands on this point.

"The challenge for Canadians is to develop a widespread understanding that innovation is not just robots and computers; equally important are organizational advances that maximize the contribution that people and the new technologies together can make. For organizational change to flourish, there must be imagination, commitment and motivation." (p. 20)

Our Clients' Views

A growing number of ISTC clients are recognizing that the development of human resources, through new directions in education and training, is fundamental to improving Canada's international competitiveness. In the course of consultations the department undertook on its mandate and at events such as the National Forum on Post-Secondary Education and the National and Regional Conferences on Technology and Innovation, ISTC's industry-based clients repeatedly expressed concerns about the need to improve the knowledge, skills and flexibility of the Canadian labour force.

The department's academic and university-based clients have been most concerned about the shortage of funding for education at all levels and for research. These themes recurred in the presentations of a number of associations appearing before Standing Committees on Regional Industrial Expansion; Labour, Employment and Immigration; and Research, Science and Technology. They also surfaced at the Standing Senate Committee on National Finance and the Senate Sub-Committee on Training and Employment of the Standing Senate Committee of Social Affairs, Science and Technology (1987). Industry associations have also asked the following kinds of questions:

- How can industry get its message across to the educational system?
- How can it influence and support new educational developments?
- How can it overcome critical skill shortages?
- How can training and retraining programs be dramatically improved?
- How can entrepreneurship and more technologically literate managers be developed?

These issues are discussed in detail in Section 3.

Our Past Record

Although human resource development may seem like a new area for the department to be involved in, ISTC's predecessors — the Department of Regional Industrial Expansion (DRIE) and the Ministry of State for Science and Technology (MOSST) — participated in a surprisingly broad range of human resource development activities that were primarily aimed at management training and the post-secondary system. DRIE undertook the following activities:

- information seminars for businesses;
- management training courses in finance and marketing that were tailored to the needs of the tourism industry;
- financial assistance to educational institutions and non-profit organizations under the industrial climate element of the Industrial and Regional Development Program (IRDP) and under the Technology Outreach Program; and
- a wide range of regionally tailored training programs under DRIE's Economic and Regional Development Agreement subsidiary agreements (ERDAs).

Major programs developed by MOSST include Canada Scholarships, Networks of Centres of Excellence and, through the Granting Councils, funding for university research and the training of highly qualified personnel.

A review of these activities leads to some interesting observations.

DRIE's non-funded activities tended to involve duplication and lack direction. For example, since DRIE did not identify a responsibility centre for human resource development activities, individual regional

offices and, on occasion, headquarters had a tendency to incur design and delivery costs for very similar business seminars.

DRIE began to shift the emphasis of its non-funded activities from basic management training for small and medium-sized enterprises to the development of training in the management of technology.

Under the industrial climate element of the department's Industrial and Regional Development Program, funds were provided for education and training (e.g., studies, scholarships or course development). However, most went to the construction of physical plants for non-profit centres and institutes. This favoured Ontario and New Brunswick, since the few centres that were built were located there.

MOSST's role was to act as an advocate for science and to develop policies on science and technology activities and expenditures within and outside the federal government. This role was eventually expanded to include funding of selected programs.

Future ISTC Plans

The tools used by ISTC will differ from those of its predecessor departments. While the department will build on the work of both DRIE and MOSST, it places much less emphasis on funded programs and more emphasis on policy advocacy and services. This change in emphasis, along with very scarce funds, makes it unlikely that DRIE's focus on capital expenditures for education and training will be sustained. ISTC is also emphasizing the co-ordination of departmental activities in human resource development in order to avoid duplication and clarify the department's role.

As an initial step in determining its role in future human resource development, ISTC has identified the following four areas as important to its mandate:

- **Management and Entrepreneurship Training**, in particular, encouraging innovative management techniques and expertise in the management of technology.
- **The Structure and Nature of Labour Force Training**, in particular, encouraging new approaches to the need for life-long learning and new skills brought about by technological change.
- **Post-Secondary Education**, ensuring a continuing supply of well-rounded, highly qualified graduates.
- **The Responsiveness of the Educational System to the Needs of Industry**, in particular, drawing attention to the needs of an economy operating in a new technological environment.

3. Major Human Resource Development Issues

This section examines each of the four human resource development categories outlined in section 2.

Management and Entrepreneurship Training

The major issues concern the quality and attitudes of management, particularly in relation to technological change and small business. They can be grouped into three main categories:

- basic management training in small businesses;
- managing technological innovation; and
- public awareness of entrepreneurship and a new type of management.

Basic Management Training in Small Businesses

There are strong indications that a lack of basic management skills (financial, technical, marketing and administrative/ human resources), particularly in small enterprises, is the principal reason both for business failure and for the fact that relatively few firms ever graduate to become medium-sized businesses.

For a variety of reasons, including shortage of time on the part of small business owners and managers and failure to recognize the need for training, not enough small business managers take advantage of training opportunities offered by both private and public-sector sources. Other reasons may be that existing management training courses are often too general to deal with firm-specific issues (such as sector marketing) or that they are not applicable to the unique requirements of a particular sector (such as advanced technology).

A recent study carried out by the Canadian Advanced Technology Association concludes that advanced technology firms suffer from a lack of corporate marketing expertise and, as a result, they fail to allocate adequate resources to marketing management. The problem is particularly acute among technology-driven companies at an early stage of development. This weakness contributes to the high rate of market failure of new product launches, leads to the inappropriate targeting of research and development (R&D) efforts, and restricts access to financing. Special management training measures are clearly needed to solve this problem.

Managing Technological Innovation

While a lack of basic management skills presents a problem, particularly for small business, an even greater problem is emerging in relation to skills required in the overall planning and management of technological innovation. According to the Economic Council of Canada:

"Canadian management must become more creative in applying technology, in deploying human resources, and in combining technical and human resources. To be truly effective, the new technologies must be managed as an integrated system, made up of both innovative machinery and equipment, and of highly skilled workers." (*Making Technology Work,* 1987, p.34)

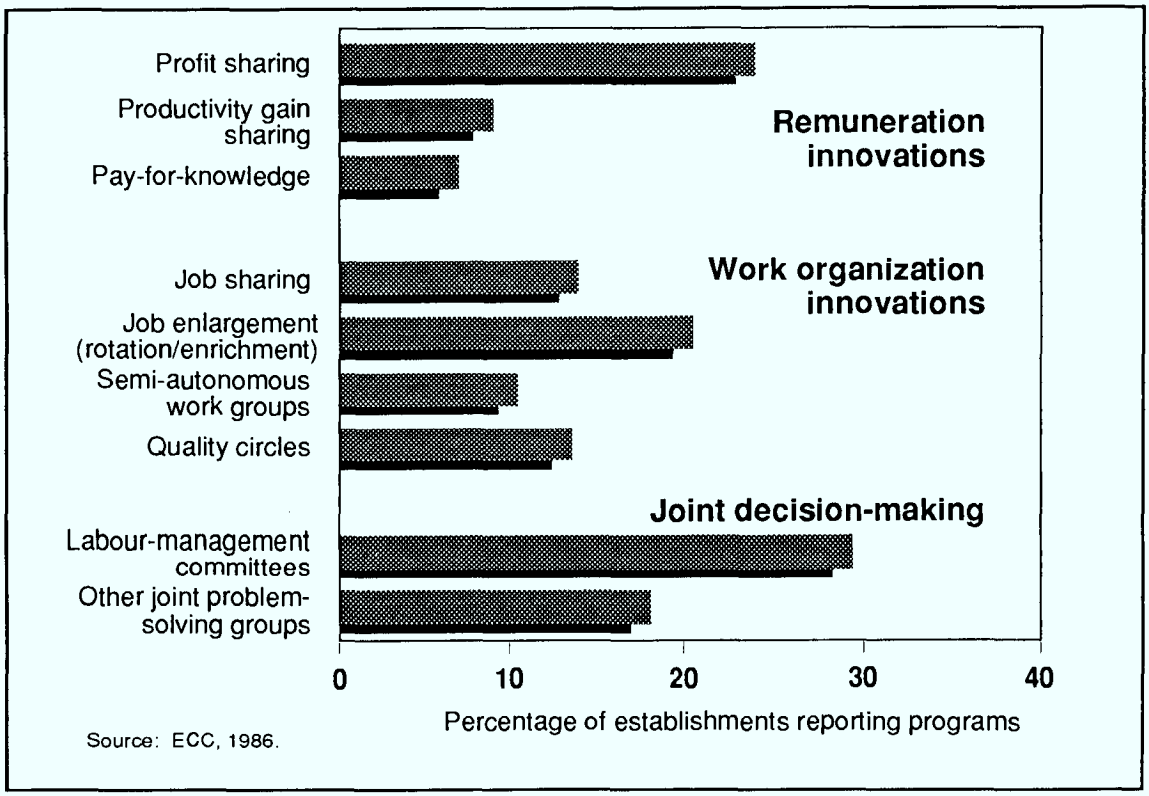
One of the most important elements of this new type of management relates to the planning process itself. Effective innovation begins long before any equipment arrives at the company door. Advance preparation inevitably pays dividends through technological change that works. While effective planning must look at the capabilities of technology and how it can be used to ensure growth, profitability and competitiveness, it must also consider implications for roles and responsibilities in the work force. The success with which one can organize work, involve people and develop an environment in which learning, creative thinking and quality are made the guiding principles will be crucial for the new work environment.

Most managers in Canadian firms have been educated in an environment that used, and for the most part still uses, traditional organizational models, encompassing hierarchical structures with centralized, top-down control. While many managers may realize the need to become more knowledgeable about managing innovation, it is doubtful that many understand the need for new and different ways of organizing the workplace to tap the creativity of workers. As Chart 1 on page 7 illustrates, a 1986 Economic Council study of 946 organizations across Canada found that less than 30 percent of those surveyed were involved in new forms of organizational innovation and that only about 20 percent were involved in work organization innovations.

The 1989 report of the Advisory Council on Adjustment, *Adjusting to Win*, claims that Canadian business executives must develop a technological innovation culture. Such a culture would directly involve employees in sharing management responsibility for the success of products or processes. The report also encourages government to help industry develop and promote management training systems designed to elicit broad employee participation in technological innovation.

CHART 1

Organizational Innovations



Source: ECC, 1986.

Public Awareness of Entrepreneurship and a New Type of Management

During the consultation process leading to the creation of ISTC, the leaders of national and small business organizations emphasized that government policy should be aimed at creating the right environment to encourage new entrepreneurs. One particular concern was the need to introduce aspects of science and technology awareness, entrepreneurship, and innovative business management into the educational curriculum at an early stage. Entrepreneurship, self-employment and risk-taking have not been adequately promoted in the past as goals for young Canadians.

"Government should determine, on an ongoing basis, the specific characteristics of successful enterprises and ensure that educational programs are focused on such characteristics to encourage appropriate expertise. Such programs should include availability of sufficient information for knowledge of the markets, developments and trends to facilitate the identification of relevant risks for market participants." (Canadian Bankers' Association)

This point of view is supported by the Canadian Federation of Independent Business, which asserts that governments and universities should develop systems of entrepreneurial education in primary and secondary schools (Ontario schools provide a good example of entrepreneurial education) as well as the teaching of entrepreneurial skills in university science and engineering courses. (*Innovation, Technology Transfer and Small Business Development*, Canadian Federation of Independent Business, June 1986).

The Corporate-Higher Education Forum has also called for more multi-disciplinary curricula to ensure that technological innovation and technical business/ entrepreneurial skills are properly understood in all disciplines. Canadian industry has stated that the newly graduated engineers and scientists it recruits are lacking in general management, communications and international business skills. (*Making the Match, Going Global*, Corporate-Higher Education Forum, 1986 and 1988).

A recent survey by Queen's University indicates that 80 percent of the respondents think there is a need for graduate level courses in technology management. In the United States and in some European countries, efforts are underway to establish such programs. Further, some American companies have found it necessary to develop their own training programs. In Canada, however, relatively little effort is evident in this area either at the university or company level.

Future discussions should focus on if and how the department could play a role in support of new developments in management and entrepreneurial training through:

- exploring new approaches to basic management training which could be diffused through appropriate delivery agents;
- encouraging a greater awareness and understanding of the management of technological innovation, particularly in relation to the integration of people and technology; and
- encouraging the development of university, community college and in-house programs to help future and existing managers develop a more multi-disciplinary approach to innovation.

The Structure and Nature of Labour Force Training

Whereas the previous section addressed problems that affect the quality and attitudes of Canadian management, this section identifies the major issues affecting the supply and quality of Canadian workers. These issues can be grouped into two broad categories:

- **Skill shortages,** reasons for them and traditional ways of addressing them; and
- **Labour force training and retraining,** existing and new approaches to training, as well as issues of delivery and overall responsibility.

Skill Shortages

In its April 1988 statement to the Standing Committee on Regional Industrial Expansion, the Canadian Federation of Independent Business indicated that its members had identified shortages of qualified labour as one of the most serious problems affecting them. Similarly, 70 percent of Canadian Manufacturers' Association (CMA) members indicated in a 1988 survey that they thought there would be a severe shortage of skilled labour in the early 1990s.

The following skills were identified as difficult to find: machinists, mechanics, tool and die makers, welders, electricians, electronics technicians, fitters, and chemical mould makers. The Canadian Restaurant and Food Services Association also reports that skill shortages are a problem and that its members must rely on immigration to fill chef and cook positions.

There are a number of reasons for the growing gap between the demand for and supply of skilled workers. Among the most obvious are:

- For a variety of reasons, many Canadians are seeking and finding work in the service sector of the economy, thus turning away from more traditional jobs in the manufacturing sector.
- Traditional mechanisms such as apprenticeship programs and immigration policy do not seem able to respond to the new challenges.
- Training programs, particularly those given in educational institutions, are slow to respond to specific skill shortages.
- Illiteracy prevents many Canadians from taking advantage of jobs or training programs that require basic levels of education.

Over the past 15 years, and particularly since the introduction of microcomputers, employment choices have shifted away from traditional trade or factory jobs and towards service positions. Many traditional factory jobs have a poor image and do not appeal to young Canadians. A number of industry associations are becoming increasingly worried about this trend and their inability to attract workers into technical jobs. The Electrical and Electronic Manufacturers Association of Canada and the Motor Vehicle Manufacturers' Association have both raised this concern.

One traditional training mechanism for preventing skill shortages has been apprenticeship programs. However, the lack of a strong apprenticeship training system remains a chronic problem in Canada. Like education, apprenticeship is regulated on a provincial basis, and industry has generally shown very little interest in making the system work better. Evidence for this is shown by the fact that, while 70 percent of CMA members are concerned about skill shortages, over 30 percent consider apprenticeship programs unimportant to their companies.

A study prepared by Woods Gordon for Employment and Immigration Canada's Canadian Occupational Projection System (*Canadian Automotive Repair and Service Industry: A Human Resource Study*) stresses the need for closer cooperation between the various players involved in apprenticeship programs and for employers to recognize their responsibilities in this area. The report states that the Canadian automotive repair and service industry must focus on the training of apprentices with skills appropriate to the present and future needs of the industry.

It is argued that this is not a task for the training institutions alone and that employers must share the responsibility. While there is a need for colleges to upgrade the classroom portion of apprenticeship programs, employers must take responsibility for the hands-on training of apprentices. The study recommends that the duties of both colleges and employers be defined clearly and that both parties be encouraged to take their responsibilities seriously.

The situation in the tool and die industry is symptomatic of how trade skills development is short-changed in Canada by a lack of strong, concerted action by both industry and government. It is well known that most of the current core labour force in this field was trained in Europe and is approaching retirement age. The shortage of apprentices to fill their places could be addressed by both industry and government.

The moulds made by tool and die makers are used in metal stamping, plastics injection moulding and pipe extrusion. The same process applies to advanced materials as well as traditional materials. Technological change is not eliminating the need for tool and die making skills. The design process is a human skill, and the best design and engineering people are tool and die makers, even though the actual process may be carried out with computer-assisted design, engineering and machining equipment.

Immigration has been another traditional remedy in Canada for skill imbalances in the labour market. Immigration policy attempts to address the demand for and supply of labour by occupational group and, to a certain extent, by region, since the provinces, especially Quebec, have shown considerable interest in this area.

Canada may have more difficulty in the future attracting and retaining professional and scientific immigrants. Not only are these skills in short supply worldwide, but also Canada is not as attractive a destination as it once was, given the rapid industrial growth of our major trading partners. Although immigration policy remains relevant to skill shortage problems, our focus in the future should be on home-grown solutions.

A less apparent reason for skill shortages is the inability of many illiterate Canadians to take advantage of jobs or training programs that require basic levels of education. Canada's combined basic and functional illiteracy rate is between 18 and 24 percent. This translates into 3.4 to 4.5 million adults. In the United States, 20 percent of the adult population, or around 35 million people, are considered functionally illiterate. The Japanese rate of illiteracy is estimated at less than one percent.

The economic impact of illiteracy is substantial. A recent Woods Gordon report on the indirect business costs of illiteracy in Canada, sponsored by the Business Task Force on Literacy, estimated the cost at about $4.2 billion a year. This estimate considers factors such as lost potential for training or promotion, accident and safety costs, lost productivity, excess supervisory time, poor and/or inconsistent product quality, low morale, and absenteeism. In addition, the Economic Council of Canada has found that in comparison with other groups, Canadians with less than Grade 9 education, often considered the literacy boundary, have been hurt by job losses related to the introduction of new technologies.

Despite widespread concern and the substantial economic impact of illiteracy, the Department of the Secretary of State reports that with limited exceptions, Canadian business has not been active in resolving the problem. Few literacy programs exist within the workplace, contrary to the situation in the United States, where literacy is seen as a bottom-line item for many companies, which are increasingly investing time and money in literacy and basic skills training.

The Department of the Secretary of State's National Literacy Secretariat is a positive step in addressing a very serious problem.

Labour Force Training and Retraining

Recognition of the growing importance of labour force training and retraining has spawned concern about the appropriateness of training programs, delivery methods and responsibility for training.

Existing education and training institutions are poorly equipped to meet current and future requirements. Although there is a critical need for employers to place greater importance on in-house training, small and medium-sized businesses may not have the operational flexibility or economic resources to deliver it. As a result, institutional training will continue to play an important role. Such training will, however, require close cooperation between industry and educational institutions to ensure that it is effective and responsive to industry needs.

Among Canada's trading partners, industrial involvement in training is well-established. A study by the Organization for Economic Cooperation and Development (OECD) titled *Science and Technology Policy Outlook 1988* reports that American firms are spending about $80 billion annually on staff training. This is close to the amount spent by all public and private universities and four-year colleges. IBM is one of the largest investors in research and staff training, devoting about 8 percent of its wage costs to personnel development. The commitment to training among Japanese industrial firms is legendary. The average Japanese employee receives 100 to 200 hours of in-plant training each year compared to only two hours for the average employee in Canada (Ontario Ministry of Skills Development, April 1988).

European industry has also moved aggressively on this front in recent years. In Germany for example, there is an apprenticeship program that is funded, managed and operated by industry, with the Chambers of Commerce setting the standards. Tremendous interaction between industry and universities is also encouraged in Germany through staff exchanges.

The growing need for more industry-based training in Canada is reinforced by the changing occupational structure within innovative Canadian firms and plants. Chart 2 on page 13 compares the changing skill requirements of a typical firm that uses computer-based technology with those of a firm that does not use this technology. Note the lower proportion of manual jobs and the higher proportion of professional, technical, sales and office workers required by the innovating firm. The emphasis in the future will continue shifting from physical to mental work, with an increasing need for a more highly educated and trained work force.

In a 1989 report *Success in the Works — A Profile of Canada's Emerging Workplace*, Employment and Immigration Canada predicts that 64 percent of all jobs created between 1986 and the year 2000 will require more than 12 years of education and training. Almost half of these new jobs will require more than 17 years of education and training. See Chart 3 on page 14.

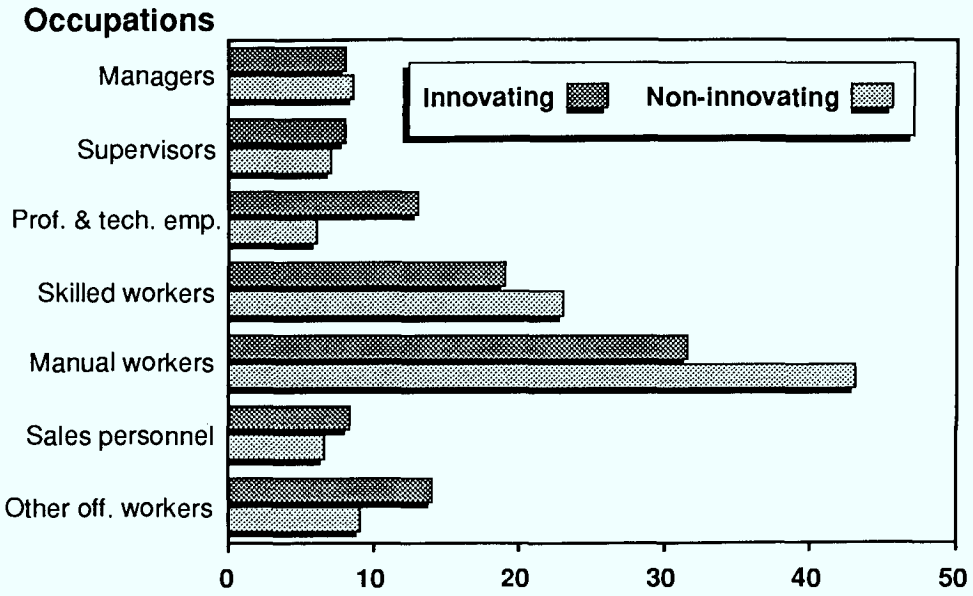
Certain Canadian industry groups are overcoming skill shortages and related vocational training problems by working more closely with provincial education ministries to develop programs that meet their specific needs. For example, the Society of the Plastics Industries of Canada and the Ontario Ministry of Colleges and Universities are working together to develop skill training profiles for four industrial processes in plastics where improved training is needed. The objective is to develop a training centre, modelled on the Plastics Industry Training Centre in Telford, England, which is industry-driven in the sense that students are selected and enroled in the training program by their employers, who pay their tuition.

A key issue for Canada is effectively balancing on-the-job and institutional training. At a time when both are becoming increasingly important, Employment and Immigration Canada is shifting away from purchasing training seats at vocational institutions and subsidizing more on-the-job training. While this move has been applauded by many in industry (e.g., the Business Council on National Issues) others (mainly labour organizations) are concerned that not all types of training can be provided effectively by employers.

Employment and Immigration's shift of focus has forced colleges with a vocational orientation to try harder to sell their services as training agents to business and industry in an effort to recapture some of the redirected funding. This could help bring about the closer cooperation that is needed among governments, educators and industry to achieve a balance between on-the-job and institutional training to meet industry requirements.

CHART 2

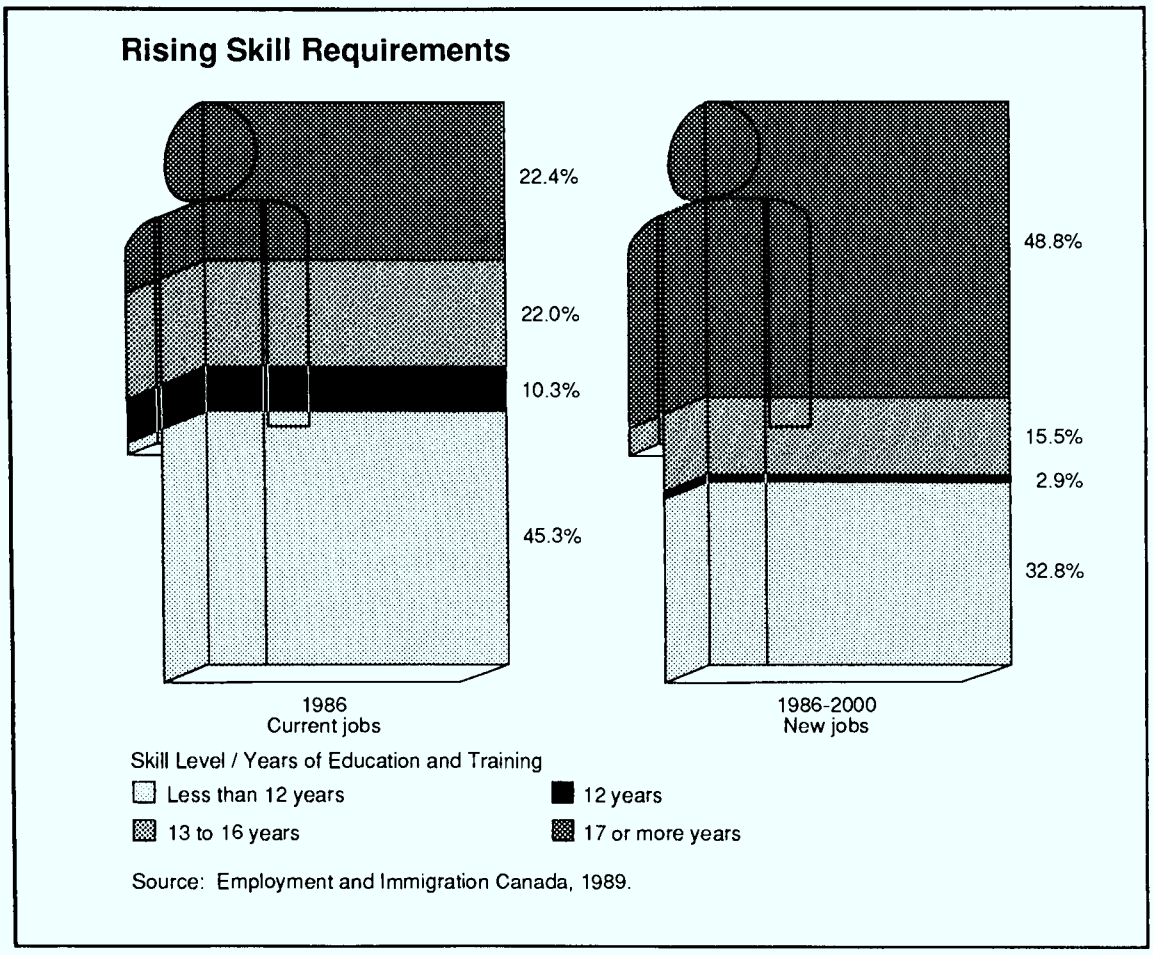
Occupational Structure of Innovating and Non-Innovating Establishments, Canada, 1985



Source: ECC, 1985.

Chart 3

Rising Education and Skill Requirements



Source: Employment and Immigration Canada, 1989.

In Canada, the community colleges have probably done the best job of responding to local industrial training needs with tailor-made programs and courses. Universities generally have not done this. When the educational system falls short in delivering the training that industry needs, industry fills the gap itself in a variety of ways. In part, the gap is being filled by private training companies (a major growth industry in the service sector), technology centres and outreach activities, self-help training programs, and other industry-led initiatives.

The leading edge of this trend takes the form of a "corporate university," an institution established by a large corporation (e.g., General Motors and McDonald's) to train its own employees. The OECD study cited previously noted the rise of corporate universities in the U.S., where many firms have formal state accreditation for degree courses up to and including the PhD level. Some firms contract specialized training needs to universities. The 1985 Carnegie Foundation report *Corporate Classrooms* identified 18 degree-granting corporate colleges and five more in the planning stage, offering courses such as semiconductor design, systems engineering and business administration.

A 1985 study by the Conference Board of Canada, *Trends in Corporate Education and Training*, reports that new technologies (e.g., interactive video) are increasing instructional effectiveness. They make it easier to train individuals rather than groups and to adopt centralized program development. The Information Technology Association of Canada also believes that information technologies can play a key role in improving education and training programs, particularly continuing education and retraining programs aimed at an adult work force adapting to change.

The training mechanisms being created by technological advances can also promote co-operative efforts such as joint ventures and cost sharing. In short, the new technologies make training more attractive for a wide range of businesses, small and big.

The impact of technological advances is reflected by an increased interest in distance education, which industry is developing to meet its own needs. Distance education includes a whole range of training activities and teaching methods and media, many of which make use of the latest audio-video technology, computer-based teaching systems, educational software and communications technology. All this helps make on-the-job training more accessible to small and medium-sized businesses.

The National Technological University (NTU) in the United States is a good example of a training venture involving many parties and may be the satellite model for the global university. The NTU is an independent, non-profit institute serving major business corporations and U.S. federal agencies. It uses advanced communications and information technology to broadcast live and videotaped courses in science and engineering to students in their workplaces. The NTU is a joint project of corporate and university concerns whereby firms such as Westinghouse, Hewlett-Packard and Control Data Corporation contribute time and resources to launch the organization while universities prepare the required courses. A version of NTU planned for Western Europe is known as the European Program of Advanced Continuing Education (PACE).

These problems and opportunities provide a basis for developing a revised agenda for federal training initiatives. The $1.5 billion the federal government currently spends on

labour force training through its Canadian Jobs Strategy will be augmented by approximately $775 million for new training initiatives. By international standards, this level of government expenditure on training is high. Nevertheless, the following questions remain:

- How can more effective use be made of existing and new funding to respond to the needs of industry, particularly in relation to skill shortages?
- How can more employer-based training be encouraged?
- How can industry, community colleges and private-sector training firms be encouraged to develop new and innovative literacy and skills training and retraining?

Questions specific to ISTC could include how the department can help industry meet its training needs by:

- ensuring that the department's sector competitiveness analyses and initiatives consider human resource requirements; and
- working closely with other government departments to ensure that policy initiatives dealing with human resource development adequately reflect industry's needs.

Post-Secondary Education

In the course of consultations on ISTC's mandate and in other meetings and conferences aimed more specifically at the university and scientific communities, two broad issues emerged in the area of post-secondary education.

The first, expressed most forcefully by industry-based clients, including the major industry associations, was the need for improved knowledge, skills and flexibility in the Canadian labour force. As well, however, industry has stated that the newly graduated engineers and scientists it recruits are lacking in general management, communications and international business skills. (See section 3 under Basic Management Training in Small Businesses.)

The second issue was raised by representatives of the university and scientific communities. They identified the shortage of funding for post-secondary education and research as the issue of overriding importance. Although cutbacks in provincial government grants to universities and colleges for capital and operating costs are an ongoing concern, the university and scientific communities have also identified three specific shortcomings of federal funding policies:

- with respect to direct funding of university research, failure to provide substantial real increases in the budgets of the three federal granting councils (see table 1 on page 18). The 1987 *Report of the National Advisory Board on Science and Technology University Committee* (Lortie report) recommended doubling the councils' budgets. Note that current resources are authorized under a five-year financial plan that expires at the end of 1990-91;

- lack of federal government funding for the indirect or overhead costs of research; and

- the reduction in the rate of growth of federal transfers to provincial governments under the Established Programs Financing arrangements intended for post-secondary education.

The university and scientific communities urge that there be no reduction in the rate of growth of federal transfer payments for post-secondary education despite the failure of provincial grants to post-secondary institutions to keep up with the growth of these transfer payments in recent years. They also would like the federal government to ensure that the funds are indeed used for their intended purpose. While provincial governments have also criticized federal action in this regard, they strongly maintain that the transfers must continue to be unconditional.

Other issues frequently identified include:

- the need to train more highly qualified scientific personnel to meet perceived or expected shortages caused by the drive for greater competitiveness;

- the under-representation of women students in engineering (about 11 percent in bachelor's programs) and science faculties, at a time when women account for over half of all bachelor's degrees awarded, and a disproportionate low number of women completing PhDs;

- inadequate, outdated research equipment in the universities;

- the need for additional funding and promotion of networks of centres of excellence;

- the desirability of more corporate funding of, and involvement with, post-secondary curricula and research, including research on strategic technologies and increased exchanges of university and industry researchers;

- the need to provide post-secondary students with industry experience, primarily through co-operative education programs; and

- the need to recognize the limitations of university-industry collaboration.

As a new department with a clear mandate to promote excellence in industry, science and technology and to ensure that there are appropriate linkages between these three areas, ISTC has an extremely important advocacy role in the area of post-secondary education.

Careful consideration must be given to such issues as the adequacy of funding for post-secondary programs in science, engineering and technology; the adequacy of funding for the granting councils; industry's need for highly qualified personnel; and university/industry linkages.

TABLE 1

Federal Funding for the Granting Councils*
1985-1989

($ millions)

	1985-86	1986-87	1987-88	1988-89
NSERC	311.6	324.1	338.0	363.1
MRC	161.5	167.9	174.5	188.3
SSHRC	64.0	70.0	69.7	75.0
TOTAL	537.1	562.0	582.2	626.4**

* The Natural Sciences and Engineering Research Council (NSERC), the Medical Research Council (MRC) and the Social Sciences and Humanities Research Council (SSHRC).

** Excludes $10 million allocated to the three councils in 1988-89 under the Networks of Centres of Excellence Program.

Source: Science Sector, ISTC

The Responsiveness of the Educational System to the Needs of Industry

The responsiveness of the educational system to the needs of industry is an area of growing concern that covers a broad range of issues, broken down into three major categories:

- basic education, including the adequacy of the core curriculum to provide basic skills and acceptable levels of literacy, and the problem of drop-outs from the system;
- science education, including science and technology literacy and awareness; and
- the relevance of education to the workplace.

Basic Education

The rapid pace of technological change presents a tremendous challenge for our educational system. New and different skills are needed, and needed quickly. Our new economy is demanding that more emphasis be placed on raising the level of basic academic skills, special technical skills and analytical skills such as problem solving, data interpretation and diagnosis.

The educational system has difficulty responding quickly to any significant change in direction. This problem is not unique to Canada, nor is it solely related to curriculum. It relates to the way in which subjects are taught and the structure within which teaching occurs.

Conventional teaching methods that were developed to cope with a relatively stable environment are dated. While educational technologies are being explored as a way to improve teaching, there is still much to be discovered about the learning process in both children and adults. Various programs in the United States are currently studying childrens' learning processes in order to establish a role for technology.

The structure within which learning occurs is another problem. In a recent article discussing how industry is attempting to save schools in the United States, the following observation was made about today's schools.

"They function much like the 19th century factories they were originally designed to resemble. Batches of boys and girls still roll like widgets from room to room where each teacher puts a part on the kid. Classes are large and impersonal, lectures predominate, and every 40 minutes, just when the children settle down — GONG — the bell sends them off to their next station. The result: gaggles of graduates with the forbearance needed for unskilled manual labour, but devoid of the problem-solving skills necessary for today's globally competitive workplace." (*Fortune*, November 1988)

It is argued by industry that elementary and secondary schools are failing to equip students with the basic skills they need to work in the new technological environment.

The core curriculum has been criticized for placing more emphasis on memorizing facts than on developing tools to learn, analyze and think creatively. It is also criticized for not focusing enough on basic skills such as reading, writing, communicating, mathematics and science.

While many employers agree that specific skills can be more properly acquired on the job or at vocational training schools, they are concerned that Canadian youths are not equipped in school with basic skills that teach them how to learn and prepare them for a life-long learning process that involves further training and retraining. Without this training and retraining potential, our labour force will be unable to adapt to a continually changing environment and will not be in a position to support and promote technological innovation and Canada's international competitiveness.

Witnesses appearing before the Senate Sub-Committee on Training and Employment in 1987 were especially critical of the education system in Canada and of the skill levels acquired by high school graduates. University professors indicated to the sub-committee that half of their undergraduate students were functionally illiterate in that they were incapable of writing correctly and logically. Many witnesses recommended that something be done to establish national standards for graduation from elementary and secondary schools.

The high drop-out rate also has a major impact on the quality of human resources in Canada and thus on our international competitiveness. Statistics Canada indicates that in 1986, 18 percent of Canadians aged 15 and over had less than grade 9 (see Chart 4 on page 22). In other words, almost one in five Canadians has fewer than nine years of basic education and is, therefore, classified as functionally illiterate.

In 1987, the Ontario Ministry of Education reported that one out of every three students in the province drops out before completing grade 12. More importantly, the drop-out rate gets worse as one moves from the academic stream (12 percent) to the basic stream (79 percent) in Ontario's high schools. This indicates that the educational system is failing to provide the skills and background to the young people who will be the most vulnerable to technological change (those in the basic stream). These students are also the least likely or able to obtain additional training or education.

In many economically successful countries (such as Japan, the Netherlands and the Federal Republic of Germany), a high proportion of young people remain in school beyond the age where they have the legal right to quit. It should also be noted that in Japan, 90 percent of all students graduate from high school.

All of the problems associated with our educational system and students will be exacerbated by technological change, which increases the threshold of minimum competencies required for literacy. Given that future economic competitiveness will increasingly depend on a highly skilled and flexible labour force, the whole area of the quality of basic education is of grave concern.

Science Education

Elementary and secondary school systems have been encouraged to prepare their graduates for the working world by increasing their science and technology awareness. It is argued that students need to understand the basics of the various science disciplines as they relate to everyday life and practical technological applications. Creative thinking and inquiry in the pursuit of science and technology must also be encouraged. Thus, science education must encourage students to

question the current world view. In this way, science education becomes education for the future and a greenhouse for future leadership.

Many business organizations have argued that the profile of science and technology in elementary and secondary education must be raised, not only to ensure an adequate supply of future scientists and engineers, but also to ensure a higher calibre of skilled and technologically aware entrants into the work force. These organizations include the Canadian Advanced Technology Association, the Canadian Manufacturers' Association, the Canadian Chamber of Commerce, the Electrical and Electronic Manufacturers Association of Canada, the Information Technology Association of Canada, the Mining Association of Canada and the Motor Vehicle Manufacturers' Association. They have stressed the need for exciting and imaginative curriculum materials to enhance science and technology literacy among elementary and secondary school children.

There is some evidence that Canadian students are lagging internationally in science and that this is a North American phenomenon. A recent report on science education in Quebec prepared for the 1988 Sommet Québécois de la technologie indicates that Canadian students in grade five compare well internationally in terms of their science knowledge, but grade twelve students are below the international average. American students also did poorly, ranking last in are as such as biology and demonstrating a knowledge level below average in all subjects tested at the high-school level. The study involved students in grades five, nine and twelve from 23 countries.

Although computers have been provided to assist in teaching science in Quebec, the study indicated that 80 percent of teachers surveyed rarely used them. Thus, the availability of new technology in schools does not ensure its utilization.

Although Canadian governments and industry are concerned about the lack of science and technology knowledge in the population, some are critical of corrective measures that focus on additional funding for industrial research and universities. For example, André Boutin, Vice-President of Northern Telecom Ltd., argues that the problem should first be addressed in elementary schools. He believes that habits such as logical reasoning and scientific precision must be developed in young students and that it is too late to develop these habits in university. (See "Science Education Lags in Quebec," The Gazette, October 12, 1988.)

Relevance of Education to the Workplace

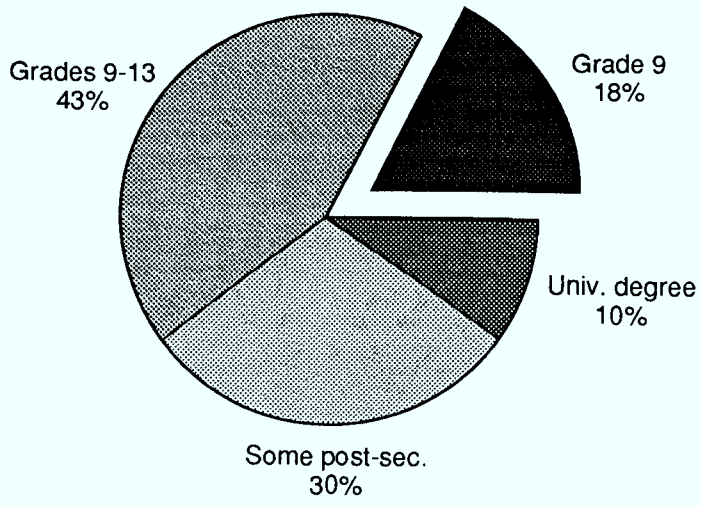
The Retail Council of Canada has pointed out that unless the secondary school curriculum is relevant to the demands students will face in the working world, and unless this relevance is stressed, the system will be unable to keep young people in school. One way of addressing this problem is to strengthen industry-education linkages.

There are few programs in Canada that encourage closer industry-education linkages. However, the Industry-Education Council of Hamilton-Wentworth has developed adopt-a-school programs in several communities. These programs have helped students become more aware of the needs of industry and career opportunities for young people. The council has also arranged industry leave for a number of teachers in order to familiarize them with the realities of the business world.

CHART 4

Canadians' Educational Attainment 1981 to 1986

Educational attainment of Canadians, aged 15 and over, Census, 1986



Source: S&T Statistics and Analysis Division of ISTC

Canada should take a close look at the success of industry-education programs in the United States, where a wide variety of innovative linkages have been developed. Here are some examples of very novel ways in which industry is helping.

- A coalition of high schools around the country has received a grant to experiment with new approaches to teaching.
- Companies have waged campaigns to lower drop-out rates, committed large sums of money to increasing post-secondary enrolment and encouraged educational reform.
- Some companies (e.g., Polaroid) have encouraged certain employees to switch careers and become math or science teachers by paying their salaries during a one-year certification program. Companies have also supported preschool programs.
- Companies have sponsored speakers that children can identify with to address the value of staying in school.

Co-operative education is another way of bringing the worlds of work and school together, at both the secondary and post-secondary levels. The Senate Sub-Committee on Training and Employment reported that Canada has few co-op programs compared with other countries. Nation-wide collaborative approaches to classroom plus on-the-job training do not exist in Canada as they do in other countries such as Germany and Austria. Co-operative education programs at the secondary level do, however, exist in every province and seem popular.

Many witnesses appearing before the committee indicated that co-operative education prepares young people well for the workplace. It has been suggested that co-operative education programs be evaluated in terms of the success with which co-op students find well-paying jobs in their fields after graduation. Such information would be useful in improving existing programs and developing new ones.

Mindful of ISTC's limited mandate and jurisdiction in education and training, future discussions could focus on:

- how the department could support industry efforts to build linkages and alliances with the educational system; and
- how the department could build on existing co-operative efforts in science and technology awareness with provinces.

4. Summary and Conclusions

Technological change is crucial to economic advancement. It is the key to improvements in productivity, global competitiveness and, ultimately, employment. However, it is widely recognized that technological change and innovation are highly dependent on a well-trained, flexible and committed work force.

ISTC has an important role to play as a catalyst in improving the quality of Canada's human resources and in assisting its industry clients to become more technologically advanced and therefore more internationally competitive.

From ISTC's perspective, four categories of human resource development have a direct impact on the ability of Canadian industries to be competitive — management and entrepreneurship training, labour force training, post-secondary education, and primary and secondary education.

In the area of **management and entrepreneurship training**, there are three important issues to consider — the need for basic management skills, particularly in small enterprises; the need for skills in the overall planning and management of technological innovation; and the need to create the proper environment to encourage entrepreneurship and, in particular, entrepreneurs with multi-disciplinary skills.

Questions to be addressed include if and how ISTC should become involved in:

- exploring new approaches to basic management training;
- encouraging greater awareness and understanding of technological innovation; and
- encouraging the development of programs at universities, colleges and companies to help future and existing managers and entrepreneurs develop a more multi-disciplinary approach to innovation.

The major issues affecting the **supply and quality of Canadian workers** fall within two broad categories — skill shortages and labour force training and retraining. A major issue for consideration is how to make more effective use of existing and new funding in response to the needs of industry, particularly in relation to skill shortages. Other important issues include how to encourage more employer-based training and how to encourage industry, colleges and private-sector training firms to develop new and innovative ways to provide literacy, skills training and retraining.

Future discussion could centre on if and how ISTC could help industry to meet its training needs. This may be achieved by including analysis of such needs in sector competitiveness initiatives within the department and by working with other government departments to ensure that policy initiatives dealing with human resources adequately reflect industry's needs.

The major issues in **post-secondary education** relate to industry's need for highly qualified scientific personnel, funding for research and funding for post-secondary programs related to science and technology.

Issues for future discussion could include: funding of post-secondary programs in science, engineering and technology; funding for the granting councils; and industry's need for highly qualified personnel.

Issues identified under the **responsiveness of the educational system to the needs of industry** are the quality of basic education, the amount of science taught in schools and the relevance of education to the workplace.

Mindful of ISTC's limited mandate and jurisdiction in education and training, future discussions could focus on if and how the department could play a role in supporting industry efforts to build linkages and alliances with the educational system and how it could build on existing co-operative efforts in science and technology awareness with the provinces.