Information Technology Skills Shortages and Responses in Four Countries

A Report to the
National Assessment of Vocational Education
U.S. Department of Education

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I. Introduction

Throughout the industrialized world, nations are facing shortages of people with intermediate and advanced competencies in information technologies. The shortfall is affecting not only the ICT[1] industry but all industries that are becoming increasingly dependent on ICT, from traditional manufacturers who are required by their customers to become e-businesses and advertising agencies that use the web, to financial institutions that manage databases and publishers that use desktop systems. The documented shortage of employees with IT qualifications is becoming a bottleneck and threat to many regional economies across the U.S. and around the world.

- A 1999 report from the U.S. Department of Commerce predicted a demand for nearly 1.4 million new highly skilled IT workers to meet needs between 1996 and 2006—1.1 million for new jobs and 240,000 for replacements (Meares and Sargent, 1999).

- A March 1999 PriceWaterhouseCoopers news release noted that "Nearly two-thirds (63 percent) of fast track technology businesses have come up short in their hiring of IT workers for their U.S. operations over the past 12 months" (Wojcik, 1999).

- The Information Technology Association of America (ITAA) estimates, based on a 1999 staffing study, a shortage of 400,000 IT workers. Over 80 percent of the firms polled said the shortage was the same or more severe than a year ago (ITAA, 1999). In early 2000, ITAA, based on a survey of 700 IT managers, estimated that demand exceeds supply by nearly 850,000. A national survey conducted by ITAA found that 86 percent of the companies reported that a workforce shortage had produced a negative impact on their business (Bridging the Gap, 2000).

Similar gaps are affecting western European economies due to economic expansion and rising skill needs coupled with declining birth rates. The ICT employee shortage was forecast by a European Union Advisory Committee in 1991 (IRDAC), which said "It will be of crucial importance to Europe to maintain and develop a workforce that can participate in the innovative developments of IT and to exploit its potential."

The Organization for Economic Cooperation and Development's (OECD) Working Party on Indicators developed a set of International Standard Industrial Classifications for the ICT sector and compared employment and contributions in its member countries in 1998 (OECD, 2000). Employment was summarized for manufacturing, telecommunications, and other ICT services. In general groupings of ICT intensity in the national economy, Ireland and United Kingdom—along with the U.S.—are among the "high intensity" countries, and Canada and Denmark are "medium intensity" countries. (Scotland is included in the United Kingdom numbers.)

[1] Although the field is generally called IT in the U.S. it is more often referred to as ICT (Information and Communications Technology) in Europe.

Table 1
Employment in the ICT Sector

Country	Employment in ICT, 1000s	Percent share in total business	Percent share in total OECD
Canada	430	4.6	3.4
Denmark	96	5.1	0.8
Ireland	56	4.6	0.4
United Kingdom	1112	4.8	8.7
United States	4521	3.9	35.2

Source: Organization for Economic Cooperation and Development, ***Measuring the IT Sector***, 2000.

Table 2
Employment by Sector

	Canada	Denmark	Ireland	United Kingdom
Manufacturing ICT employment	104,504	21,837	34,339	302,896
Telecommunications ICT employment	112,421	19,226	11,705	192,769
Other ICT services employment	213,021	55,302	9,688	615,964
Total ICT employment	429,946	99,365	55,732	1,111,630

Source: Organization for Economic Cooperation and Development, ***Measuring the IT Sector***, 2000.

In Ireland, manufacturing employs more than half of all ICT workers. Canada has the highest proportion of its ICT workers in telecommunications, while Ireland and Denmark employ the largest proportions in their respective countries in other ICT services (Table 2).

By 2010, half of all jobs in the European Union (EU) are projected to be in industries that are either major producers or intensive users of information technology products and services. There is some fear that the next generation of Europeans will lack the requisite IT skills that their international counterparts have. A skills gap already exists with unfulfilled demand for highly qualified workers—limiting growth in software, services and telecommunications sectors. The shortage of IT specialists in Western Europe could reach 1.6 million equivalent jobs by 2002. A major issue is the dichotomy between this shortfall and the high unemployment rates in countries (Button, 2000).

The EU Commission has articulated an approach to ICT in ***Strategies for Jobs in the Information Society***. It addresses and elaborates on the challenges of the Information Society across four pillars: employability; entrepreneurship; adaptability; and equal opportunity. The report synthesizes the best practices of member nations with respect to (a) easing the transition from school to work, (b) making it easier to start up and run

businesses, (c) exploiting new opportunities for job creation, (d) modernizing work organization, (e) supporting adaptability in enterprises, (f) tackling gender gaps, (g) reconciling work and family life, and (h) promoting a labor market that is open to everyone. The Commission's recommendations included linking all schools to the Internet by 2002; ensuring that all teachers are competent in information skills; ensuring that all workers are information technology literate; applying user-friendly standards for equipment to improve the employability of people with disabilities; encouraging entrepreneurship through fiscal policies rewarding risk-taking; and promoting the use of information technology tools by small and medium enterprises.

A. Approaches to Meeting ICT Skill Needs

Approaches to addressing IT skill needs in the four countries take six different forms: They are:

1. **providing core ICT skills to everyone (ICT literacy)**
2. **using ICT as a tool for learning to increase comfort and familiarity**
3. **establishing a national resource center for ICT**
4. **preparing youth for ICT careers in a variety of fields**
5. **retraining and certifying people already in the workforce**
6. **attracting more youth, with emphasis on non-traditional students**

1. Building Core ICT Skills ("ICT Literacy")

The European Union's European Union for the Development of Vocational Training (CEDEFOP) asserts that "information technology is omnipresent in all fields of human activity" (Gonzales, 1996). The major European initiative to ensure ICT skills among the general population, as well as skill standards, is the "European Computer Driver's License." This is a program created by the Council of European Professional Informatics Societies to award a "license," which certifies (to employers) that the holder has a standard of competence regardless of nationality, residence, age, or sex. Certification requires the completion of modules in basic concepts of IT, computer use and file management, word processing, spreadsheets, databases, presentations, and information and communications. This concept has spread beyond western Europe and, as an International Computer Driver's License, is widely used in South Africa, Australia, and other nations.

In addition, **Scotland** includes ICT as one of five core competencies that every person must master in order to qualify for a Scottish Group Award.

In **Ireland**, School IT 2000 includes a Technology Integration Initiative to put 60,000 multimedia computers in Irish schools by the end of this year (2001). A Teaching Skills

Initiative (TSI) for the professional development of teachers will enable more effective ICT adoption by schools, while a Schools Support Initiative (SSI) will provide schools with continuing support and advice to enhance the use of ICT in the classroom.

2. Integrating ICT into the educational process

Most European nations are moving quickly to incorporate ICT into the teaching and learning process, both as a tool for expanding delivery of programs and as a resource for self learning. The **United Kingdom's** University for Industry (UfI) and National Grid's are both national systems that are Internet-based. The UfI has developed into a powerful tool, with 139,000 users between November 2000 and February 2001 for approximately 4,400 hours of learning on line. But the UfI has also contributed to skill development ***in*** ICT. Courses for ICT users and for the ICT industry have proven to be the most popular.

In **Denmark**, there is a PC with multimedia facilities for every 2.8 students in vocational colleges, and all schools are linked to the nation-wide sector net, a high-speed network used for collaborative as well as administrative purposes.

In **Ireland**, a special task force on e-Business under the Government's Expert Group on Special Skill Needs contends that nearly all companies will need people with IT skills and that the nature of the use of IT crosses technical ands business applications. They recommend not only an increase in IT subjects in most programs but an increase in IT and e-business related academic content across all business disciplines.

3. Establish a national resource center for ICT

With the explosive growth of ICT learning and resources, national centers have formed with government support to coordinate and accelerate the application. In **Denmark**, the Center for Technology Supported Learning (CTU) was established by the Ministry of Education in 1995 to "support the development of appropriate and technological environments and of new opportunities for the learning of the future." It was charged with boosting the quality of and promoting the use of computer-based learning and funded to award grants to innovative projects at colleges and universities. The Center was established for a period of five years, and in 2001 it was merged with the new Learning Lab-Denmark.

In **Scotland**, the Scottish Council for Educational Technology (SCET) is a non-governmental research center, technology advisory center, and generally a hub for technology-based education, teacher training, new teaching resources, and web sites. In July 2000, SCET merged with the Scottish Consultative Council on the Curriculum as became Learning and Teaching Scotland (LT Scotland). The organization advises the Scottish Ministers and develops curriculum products and services that support learning and teaching.

In the **United Kingdom**, the National Center for Educational Technology receives funding from the Ministry to identify the relevance of new technologies to education, evaluate the potential of new educational technologies, and promote the effective use of IT across all sectors.

4. Preparing youth for ICT careers in a variety of fields

The four countries are each, in their own ways, trying to expand the occupational programs offered in ICT fields. In Scotland, a Group Award in Computer Sciences is the most direct path into the system. Ontario offers a variety of applied credentials including computer programmer analyst, computer programmer, computer engineering technician, computer systems technology, computer systems technician, and business administration-information systems. Many of the studies of ICT skill needs have concluded that higher education is generally needed, although there is still a considerable demand for less-than-baccalaureate credentials.

In places with acute shortages such as Ireland where time is of the essence, the colleges have created accelerated programs that compress learning into a shorter time frame.

5. Re-training and certifying people in the workforce

A large proportion of those successfully working in IT fields received their education in other fields and acquired the new skills either through additional formal education or through self study. Multi-skilling/conversion courses are a common approach. In Ireland, about 1,100 people annually receive their qualifications by converting past skills into technical fields—most often in software-related occupations. But the Irish Expert Group believes that they could raise that number by about 350 annually with more aggressive marketing. Similarly, employees' skills could be upgraded to produce an additional 300 technicians per year.

To meet the growing need of companies for specific certification, each of the nations is also quickly expanding its vendor-based programs—though not quite as quickly as in at U.S. colleges. The United Kingdom has moved fastest, although nearly all Institutes in Ireland and half of Ontario's CATs already offer Cisco training.

Table 1
Colleges with Certification Programs in 2001 (To be completed)

Certification	Ontario	Denmark	Ireland	Scotland	England, Wales, Northern Ireland
Cisco Academies	12	6	12	5	60
Oracle Academies	0	0	3	6	98
Microsoft Certification	-	-	1	9	30

Note: Data unavailable on cells with dashes.

6. Attracting youth to IT careers, with special emphasis on non-traditional students and immigrants

Two quite different policies are used to expand the IT labor force. A long-term strategy is to attract more entrants, especially those who have been underrepresented, such as women and minorities. In the U.S., the gap between access of blacks and whites to the Internet grew by 39 percent between 1994 and 1998.[2] A 1999 report from the U.S. Department of Commerce stated that women and minorities are underrepresented in professional IT work—most often attributable to under-representation in the educational pipeline. These same issues face other countries, compounded by a lack of interest in any scientific or technical careers among all youth. A survey of Leaving Certificate students at seven schools in and around Dublin, Ireland in 1999 found that only seven percent were studying either computer studies or IT, despite the high demand and high salaries. Seventy percent said they received too little information about these technology programs at Ireland's Institutes of Technology (Goold, 1999).

The countries studied are making special efforts to attract new immigrants, travelers, and older adults by, for example, providing additional funding and better preparation in the secondary schools. But the larger issue is viewed as too few youth acquiring the prerequisites to enable them to get into the pipeline for IT careers. In Ireland in 1997, an EU initiative was used to create a Technology Awareness Program (TAP) that encouraged youth to take advantage of opportunities in the technology sector. The United Kingdom is about to announce a major initiative called "Science Year" that is aimed at increasing interest in science and technology among youth.

A shorter-term and quicker response to the IT skills gap is to recruit workers from other countries or encourage national emigrants to return. Ireland is setting up job fairs to promote technical employment opportunities in Ireland. The nation represents the second largest source of H-1B professionals in the U.S., and Ireland would like some of their IT skilled people to come back. Of 44,000 people who immigrated to Ireland last year, 57 percent were returning Irish nationals. Scotland also is actively recruiting professionals to move to Scotland.

[2] "Large racial gap found in access to Internet," *Raleigh News & Observer*, July 9, 1999

II. IT Skill Development in Ireland

The growth of Irish industry in the 1990's is comparable to that of Asian countries in the 1980's, as belied in Ireland's nickname, the ***"Celtic Tiger."*** For much of this century and well into the 1950s, Ireland was a disadvantaged nation, with weak economic growth, high unemployment and a limited industrial sector that served mainly domestic markets. Only six percent of the nation's non-food output was exported. Beginning in the 1950s, it attracted many branch plants, but most jobs were low skill and low wage. Few youth entered higher education, and the population was poor and declining in numbers. Ireland was still near the bottom of the scale on most European Community indicators of economic vitality and prosperity just a decade ago.

But today, thanks largely to the success of its system of regional technical colleges (since 1998 called Institutes of Technology) established in 1972, Ireland is emerging as Europe's strongest economy, particularly in computer electronics and software and in the chemical and pharmaceutical industries. The last decade of the twentieth century has seen rapid economic development and growth resulting in lower unemployment, rising salaries, and immigration to Ireland of companies and job seekers from around the world. The Republic of Ireland has attracted forty percent of all U.S. electronics investments in Europe over the past ten years, with Intel, Dell, IBM, Digital Equipment, Apple Computer, Analog Devices, DEC, Hewlett Packard, and Motorola just a few of the firms locating in Ireland.

Given the domination of branch plants in the economy, the growth of homegrown IT companies has been an important event. Irish-designed software totals more than $1 billion in sales. There are more than 600 Irish companies, and the Irish software industry employment is now split about fifty-fifty between the externally owned trans-national corporations (TNCs) and indigenous Irish-owned companies (O Riain, 2000). The TNCs generate most of their revenues from exports and have more low-end work while the Irish firms do more domestic work and offer more highly skilled jobs. The indigenous firms are highly networked for technology development, marketing, and R&D (86 percent are in alliances), as are their employees.

A. IT Labor Markets

As the economy continues to grow, young people are returning to Ireland in droves—but still not in sufficient numbers to meet the increasing needs of industry for technical workers—particularly in information technology. The Ministry for Enterprise, Trade, and Employment estimates that the country will need 200,000 more workers by 2003 (Mudd, 2000). One estimate suggests that about 300 graduates return each year. Ireland is facing a national crisis of being too successful too quickly.

Ireland's continuing growth will depend upon the ability of its government to forecast and proactively meet the challenges of emerging information technologies and recruit

people to fill the positions. In short, Ireland's continued success depends upon the quantity and quality of its mid-skilled and high-skilled technology graduates.

To assess changing workforce needs and develop strategies to meet those needs, in 1997 the Irish Government established the Business, Education and Training Partnership. It was charged with five specific objectives:

- To systematically identify the skill needs of various sectors and advise on the actions needed to address them;
- To develop estimating techniques to assist in anticipating future skill needs and requirements of the economy and associated resource requirements;
- To advise on the promotion of education/continuous training links with business at national and local levels
- To consider strategic issues in developing partnerships between business and the education/continuous training sectors to meet the skills needs of business; and
- To advise on ways to improve the awareness of job seekers of sectors with high demands for skills, the qualifications required, and how they can be obtained.

B. Special Studies

A draft position paper from the Federation of Electronic and Informatic Industries called "Ireland's ICT Manufacturing Sector: Delivering Skills for the Future," issued in April 1998, takes a hard look at the skill issues. This industry has an annual growth rate of 15 percent (1,500 + per year technicians and 1,360 programmers) and is facing major skill shortages. Multi-nationals, they assert, are already turning down expansion projects as a result of skill shortages. The paper states that government should be less concerned about improving quality than in increasing quantity of technicians. They charge that the government is denying opportunities to young school leavers and is too slow in increasing technical places in the colleges. It asks for more "work placements" (internships), more cooperation with industry, more effort to attract women, and improvement in research links with industry. The federation suggests more second chance routes, accelerated curricula, more internships, more colleges offering diploma and certificate courses, and building more human skills into the technical curriculum. They also ask for a distance learning option for the final year of the diploma program so the learner can be employed, and suggest tracking partly qualified people who might continue or reenter their education program. The report expresses concern about Institutes moving toward degrees instead of promoting the certificates and diplomas that it contends workers need.

Another study examined the future supply and demand for construction, chemical/biochemical, and IT industries and for researchers, with emphasis on post-secondary education and recommendations (Minister for Enterprise, Trade, and Employment, 2000b). For the two technical programs (chemical and IT), the group recommended adding places in higher education, expanding the "accelerated technicians" program, "re-branding" courses with new names to make them more attractive to students; it also recommended that companies encourage employees to return to IT colleges to upgrade skills and acquire new credentials.

1. Reports of the Expert Group on Future Skills Needs

Responsibility for technology policy in Ireland is shared by the Ministry of Education and Science and the Minister for Enterprise Trade and Employment. To address the emerging skill needs and shortages, in 1998 the two ministries appointed an ***Expert Group on Future Skill Needs*** (1999) to work alongside the Business, Education and Training Forum. Both are subsidiary to the Business, Education and Training Partnership. In their charges to the group, the Ministers acknowledged that "an adequate supply of the skills required by industry will be a key determinant of the future growth potential of the economy" and that "providing specialist skills can take up to four years and needs are difficult to estimate accurately." In 1999, the group released a first report that focused largely on information technology skills.

In its reports, the Expert Group, through its own and commissioned research, reviews the projected labor needs of Ireland's expanding economy. The Expert Group is especially concerned with the rate at which professionals are finishing their training and entering the workforce. The research concluded that 8,300 computer scientists and technicians would be needed per year but 6,100 would be supplied, with the greatest shortfall in technicians. Suggested remedies for technicians included employee up-skilling (through evening or weekend programs), yielding 300/year; improved completion rates, yielding 350/year (in 1998 completion among technicians was only 35 percent); and sandwiching or blocking and accelerating education, yielding 650/year. Another option is attracting more returned emigrants and immigrants.

These strategies will have a chance to work only if there are students wishing to enter the field. A substantial effort, therefore, also has to be made to attract applicants. The Expert Group predicted that the numbers of students in technology-related courses has already increased, from 17 percent of students in 1989, to an expected 25 percent by 2003. In order to meet this projected figure, the secondary schools will also be called upon to help inform and guide students into the technology sector. The ***Skills Awareness Campaign*** and the ***Science and Technology Awareness Programme*** both aim to increase interest and awareness of secondary students in technology and science. In addition, the awareness of those FÁS has several initiatives that address this need: The High Skills Pool, EURES, FÁS Opportunities, Overseas-Sponsorship Programme, WATIS and Language Register. The National Skills Opportunity Awareness Programme, established in 1996, also works to increase awareness of opportunity in technology (especially among school leavers) and works in secondary schools and with national media to attract interest in its programs.

In sum, the recommended strategies are pro-active and in line with a high growth model of expansion, which Ireland hopes to maintain by, in part, ensuring a qualified workforce. Several other models produced include a limited growth model and a recession model. These latter scenarios were discarded, as the Expert Group determined that there was minimal economic harm in over-producing technologists. Indeed, overproduction of technologists was considered a strategy, such that outside companies would be attracted to Ireland's abundant, and therefore low-cost, workforce.

The Expert Group published a second report in 1999 in which projected demands for information technology technologists were revised (increased) and in which the Government's responses to the first report and recommendations were reviewed. The projected demand for IT technicians, for example, was boosted from 2,500 per year in the first report to 4,700 per year. The Government responded quickly to the challenges outlined in the first report. Measures include:

January 1999: ***Accelerated Technicians Programmes*** expanded to include IT. As a result, an additional 1,100 students were enrolled.

April 1999: an allocation of IEP 75 million to Department of Education and Science for 5,400 IT third level places in third level institutions.

June 1999: an additional IEP 6 million to post graduate conversion courses in IT, roughly 1,500 students.

In Ireland, the Expert Group relied on the following data sources in compiling its forecast and recommendations for the information technology sector:

- ESRI/FAS Manpower Forecasting Model
- analysis of skill needs in electronic hardware sector
- analysis of skill needs in software sector
- examination of supply of professional and technician graduates
- survey of skill needs of internationally trading sector
- review of skill studies

The Expert Group's 2000 recommendations include:

- giving priority to the Accelerated Technician Programmes
- permanently funding programs which serve adult workers and students, such as the Accelerated Technician Programme
- further encouraging companies to work with non-third level qualified workers to seek third level training (degree, diploma or certificate)

2. Report from the Information and Communications Technologies Panel

Forfás, Ireland's policy advisory and coordinating board overseeing industrial development and science and technology, provided secretariat and research skills to the Expert Group. But it also publishes its own annual "Review and Outlook" reports

that set the tone for the coming year's investments and strategies. In 1998, Forfás and the Irish Council for Science, Technology and Innovation (ICSTI) named an Information and Communications Technologies Panel to review the needs and potential of the sector (Technology Foresight, 1999). The Panel noted that ICT accounted for 5.1 percent of total employment, 16 percent of the increase in employment between 1990 and 1997, and 40 percent of all exports. Though proud of these accomplishments, the Panel also noted that PC use among the general population in Ireland and the nation's ICT investments per capita are both less than the EU average, and that Ireland is the only northern European country below average in this category. The Panel unanimously identified human capital development at all levels as its priority in preparing for the future. At the tertiary level of education, it recommended recognizing part-time degrees and multi-discipline (modular) degrees, reviewing and streamlining curricula, and making education a lifelong activity.

Forfás acknowledged the fast growth in the telecommunications and e-commerce sectors. In order to ensure that Ireland remains competitive, the National Competitiveness Council released a set of priorities that addresses issues such as social cohesion, labor-force availability, skills development, infrastructure, regulatory reform, and science and technology, among others. From these priorities, the government responded with a ***National Development Plan*** for the years 2000-2006.

One component of the ***National Development Plan (NDP)***, which is in response to competitiveness priorities (especially the Technology Foresight Report, released by Forfás), is the Irish Council for Science, Technology and Innovation. This Council is funded at IEP 560 million over the next seven years and is charged with supporting research into strategic technologies. A second important component of the NDP is Research, Technology Development and Innovation (RTDI), which received an allocation of IEP 1.95 billion. Specific priorities for RTDI include: strengthening third level and state research capabilities; strengthening support to researchers (students and faculty) in third level and state institutions; building both quantity and quality of RTDI links between business and third level institutions; helping businesses develop new products, along with services; building the quantity and scale of the RTDI sector; promoting exploitation of international research developments; and building RTDI into the culture of SMEs. Overall, the Government has responded quickly and with major funding to perceived emerging skills and competitiveness needs.

Ireland has invested particularly heavily in two IT sub-sectors: telecommunications and e-commerce. Forfás recognizes that this investment will need further development and support if it is to maintain a competitive place among emerging nations. Forfás, in 1999, released a report that specifically addressed the needs of the e-commerce sector. While Ireland is currently enjoying an increase in foreign investment in e-commerce and telecommunications firms, Forfás believes that this increase can be solidified with further regulatory policies, a standardized skill base, and continued monitoring of the impact of e-commerce on the larger economy. Forfás specifically recommends giving the Office of the Director of Telecommunications Regulation (ODTR) clear and

adequate objectives, powers and resources to fulfill the mission of supporting the e-commerce sector.

C. Responses To Labor Market Demands

1. ICT Literacy

Ireland has taken an aggressive approach to IT literacy in its Schools IT 2000 Program. Recognizing that the country lags significantly behind many of its European partners in integrating information and communication technologies into its educational system, Ireland is taking steps to integrate these technologies across the curriculum. A key objective of Schools IT 2000 is to create a partnership involving schools, parents, local communities, and colleges together with public and private sector organizations to meet the project's aims. The government's investment in the program will be enhanced through the efforts of the project's industrial partners.

Among the intended outcomes of the program are a comprehensive national policy on the role of information and communication technologies (ICT) in Irish schools, together with a strategic action plan specifying the activities and resources necessary to fully implement policy. A National Centre for Technology in Education (NCTE) has been established at Dublin City University to manage the implementation of Schools IT 2000, to develop information and communication technologies policy proposals, and to provide policy advice to the Department of Education and Science.

School IT 2000 includes three initiatives. First, a Technology Integration Initiative ensures at least 60,000 multimedia computers in Irish schools by the end of this year (2001). At least one multimedia-ready computer system with Internet access was placed in each school by the end of 1999 with the NCTE subsequently developing mechanisms to support schools in building up ICT equipment infrastructure. Second, a Teaching Skills Initiative (TSI) for the professional development of teachers will enable more effective ICT adoption by schools. This involves the development of a complete ICT skills program to ensure teacher progression from novice to expertl; the program will be provided to 20,000 teachers (at least one teacher per school). A forum involving representatives from the Department of Education and Science, colleges and schools of education, education centers, teacher unions, parents, and certifying bodies will be established to advise on planning and implementation. Colleges and schools of education will be consulted about appropriate support mechanisms for pre-service training in the use of ICTs in the classroom for all student teachers. Third, a Schools Support Initiative (SSI) will provide schools with continuing support and advice to enhance the use of ICTs in the classroom. Every school will be supported in producing a technology plan to support its broader educational goals, and technical support for equipment will be readily available.

2. Advanced Skill Shortages

The lack of adequate trained cannot be over-emphasized. There is high level of demand for trained IT technologists from the sub-degree through degree levels that is expected to increase, if the trends of the last 10 years continue. Specific strategies for moving students into training and into the workforce are called for and have been supplied. The effectiveness of government initiatives has yet to be determined, however, as we are only several years into the plan. It is already clear, however, that third level institutions are responding to the need. Both increased construction and investment in technology at third-level institutions speak to an increased student load, reflecting greater awareness and interest in the benefits of a third level qualification, even if it is not in information technology.

The Accelerated Technician Programme is an accelerated approach to overcoming skill shortages in key fields, including IT. It alternates six-month assignments in a college, then a business, and back at the college to produce a certificate in a year and a half, with the student earning a salary one-third of the time.

Multi-skilling or conversion from other disciplines is another approach underway. A large proportion of those successfully working in IT fields received their education in other fields and acquired the new skills either through additional formal education or through independent study. In Ireland, about 1,100 people annually receive their qualifications by converting past skills into technical fields—most often in software related occupations. But the Irish Expert Group believes that they could raise this number by about 350 annually with more aggressive marketing. Similarly, employees' skills could be upgraded to produce an additional 300 technicians per year.

III. IT Skill Development in Scotland and the United Kingdom

The economy of Scotland, like that of Ireland, has benefited greatly from investments by U.S. computer and electronics companies. In 1997, spending on IT equipment represented 40 percent of total investment in Scotland. More impressive, the nation produced 37 percent of Europe's branded PCs, half of its ATMs, half its computer workstations, and 70 percent of Europe's laptops (McMillan, 1997). The growth, however, has strained its ability to meet the demand for workers who are qualified in information and computer technologies (ICT). A government-appointed Digital Scotland Task Force (2000, p. 35) warned that "skill shortages may inhibit Scotland's progress towards a competitive information society. Companies and the HE [higher education], FE [further education] and training sectors should be alert to ICT-related skill shortages and should take anticipatory action."

A. IT Labor Markets

Prior to 1998 the ***Advisory Scottish Council for Education and Training Targets (ASCETT)*** was the body responsible for monitoring needs and recommending goals, in order to maintain Scotland's competitiveness in a global economy. Globalization, the agency notes, will depend upon high-tech innovations, including information and communications technologies. Scotland's competitiveness will depend, therefore, on its ability to keep up with technology innovations. Scotland's future requires a skilled workforce with the ability to install, service and operate a new wave of machinery—machinery that resides in computer chips and fiber optic cables. As a result, Scotland's economic development agencies have a strong interest in how well the education system can respond.

In 1995, the IT Skills Working Group contracted for a study of the match between supply and demand for IT skills, particularly among small and mid-sized enterprises, or "SMEs" (Yellowbrick, 1995). The report projected a worsening, already-large shortage. It found, among other things, that SMEs are unaware of what the colleges have to offer and want not only qualifications but work experience, so that employees can make early contributions. Students, they found, want opportunities for training, which larger companies have, and are relatively unaware of possibilities in SMEs.

The estimates for IT professionals employed in the entire United Kingdom range from 499,000 to 708,000, and the growth between 1996 and 2002 was projected at between 28 and 34 percent (Beard and Breen, 1998). There was evidence of skill shortages in 1998. One survey estimated that over 90 percent of the IT companies recruited to the UK experienced difficulty finding IT workers. Many leave to become independent contractors. Other surveys found that small and mid-sized companies had considerable trouble attracting and retaining IT professionals. Specific competencies most in demand in 1998 included Oracle, Unix, C/C++, Visual Basic, and Windows NT.

B. Special Studies

1. Digital Scotland Task Force

Scotland emphasizes the importance of lifelong learning and the necessity of including ICT exposure at all levels of the learning cycle. Scotland is included in the ***National Grid for Learning*****,** but has plans that extend beyond the Grid, as it continues towards its goal of leading the United Kingdom in achievement and economic gains. The recently published report from the ***Digital Scotland Task Force*** (May 2000) outlines the vision, foundations and implementation strategies for insuring that Scotland remains at the crest of the technology wave. The task force makes 68 recommendations for future policy regarding the transition from twentieth century economy and communications systems into the twenty-first century—a transition based upon continuing development of digital technologies. The recommendations are grouped into categories, as follows:

- education and training
- Higher and Further Education
- e-public services
  - developing better leadership, strategy and coordination
  - achieving 100% electronic service delivery
  - focusing services on the citizen
  - building trust and promoting take-up
  - developing e-democracy
  - improving efficiency and reducing costs
- e-inclusion and e-communities
  - providing universal access
  - providing information and services relevant to need
  - increasing take-up of on-line services
  - developing leadership and coordination
  - building communications infrastructure
  - organizing information
  - following through

The Task Force's recommendations show an awareness of the evolution of digital technology, including ICT, and the need for inclusion of all aspects of shared community life into networked systems. The threat exists for segments of the population to be increasingly excluded from the government as ICT systems become the backbone of communication and information processing. Scotland's emphasis on implementing an educational approach to skills training is both an efficient mode of delivery and a means of exposing as many citizens as possible to basic ICT skills.

2. Knowledge Economy Task Force

The ***Knowledge Economy Task Force,*** a branch of Scottish Executive, was charged with studying and framing recommendations that specifically target e-commerce and ICT, especially as regards skills needs and training. While the results of their study have not

yet been published, the Digital Scotland Task Force referred to their progress in various sections of the Digital Scotland report. It is clear from recommendations made that lack of a skilled workforce is a threat to be avoided through careful and far-sighted training programs, and through the implementation and use of the Grid.

3. Studying Glasgow's Economy

In 1997, Scottish Enterprise Glasgow contracted with Services to Software to survey the needs of software companies in Scotland's largest city. The sector at that time anticipated 36 percent annual growth, and the major barrier to growth was the size of the local labor force. A subsequent paper produced by the Scottish Enterprise Glasgow (SEG) two years later, in 1999, noted that Scotland's share of applications to tertiary level computing science courses in the United Kingdom had decreased over the past four years and that "the IT/software industry appears to have a poor image as a potential career, particularly as a career for women."

This shortage posed a concern to the city's development agency that projected 2,000 additional software development jobs, and it contracted for a study of advanced IT skill needs in Glasgow (EKROS Limited, 1999). The consultants estimated that the total supply of employees who had advanced IT skills in 1999 (the definition of "advanced" only loosely defined) was between 4,000 and 7,000 contractors ("project by project" workers) and between 8,000 and 15,000 permanent staff. The biggest IT shortfalls, based on a high demand but low supply, were projected to be in web design skills and Oracle software skills. Although many of the IT positions require university degrees, the consultants acknowledged the role of FE colleges. In 1996/96, 216 students in Glasgow and 813 students in Scotland completed a full-time advanced IT course. Yet retaining graduates in the local labor markets has proved difficult, and one local official estimates that 40 percent of computer science graduates in Glasgow leave the area to get higher paying jobs. As a result, SEG developed an IT Company Growth Program to assist Glasgow companies in graduate recruitment and training.

C. Responses to the Demand

1. ICT Literacy

Equally as more important as preparing a work force, Scotland aspires to become a digital nation in which growth and prosperity are based on the widespread access to and use of ICT, which requires that most people become familiar with the use of ICT. The Task Force dealt much more broadly, concerned not just about the ICT specialist technicians but the application of ICT to all walks of life—particularly education. The report notes that "as demand for skills rises in an economy where knowledge is increasingly important, there will also be further growth in the commercial training industry…using the advantages of well-designed ICTs, is a significant business growth opportunity." Scottish Executive has made a commitment that "by2003, every school leaver will understand information technology." The United Kingdom's Department for Education and Employment recommended that "the education sector provide a solid

underpinning in the fundamentals of IT, allied to associated skills such as communication, business and project management" (Beard and Breen, 1998).

In addition to participating fully in the European Computer Driver's License programs, the Scottish Executive took into account the centrality of IT skills to all occupations in the re-structuring of its credentialing program through ***Higher Still***, the national reform implemented in 1998. The reform requires that every student in all programs master a set of core competencies that can be applied to a range of contexts. Information technology skills was designated one of five sets of core skills, along with problem solving, numeracy, communications, and working with others, that are required of all learners regardless of program. This core competency is concerned with the electronic collection, organization, analysis, presentation, and communication of information. Although not intended to produce IT specialists, it does require an ability to use IT systems to support a range of information processing activities.

2. ICT as a Learning Tool

Another United Kingdom-wide response to the increased Information and Communications Technology (ICT) need that is being implemented is the ***National Grid for Learning (NGfL)*** plan. The NGfL symbolizes government's approach to ICT needs; that is, include ICT skills development at all stages of the educational cycle, including the lifelong learning strategy (which includes further, higher and continuing education). The "Grid," as it is commonly called, is less a technique than an infrastructure established and premiered in 1998, UK NetYear. The Grid was developed following an evaluation of projects that incorporate advanced technologies and was based on consultants' reports from both within and outside of the Department for Education and Employment. Recommendations, which resulted in the Grid, were first published in the DfEE consultation paper: "Connecting the Learning Society," published in 1997.

As an infrastructure rather than methodology or incentive, the Grid calls for the installation of hardware and the training of those who will assist in skills development. In this way, a structure is established whereby ICT skills develop because of common practice or cultural norm, rather than as a special or innovative skill. The Grid will incorporate educational materials available on the web, and therefore available to a wide range of learners, including not only students but instructors as well. A large component, in fact, of the Grid system focuses on maintaining high standards and qualifications for teaching staff, against a background of a very futuristic computer-based communications and learning system.

The proposal for the Grid details specific targets for ICT. They are:

- by 1998, plans for the Grid should be in implementation
- by 1999, all new teachers would need to be ICT-literate to receive Qualified Teacher Status.

- by 2002, all serving teachers should be confident in using ICT (compared to the roughly 65 percent at present)
- by 2002, all schools, colleges, universities, libraries and as many community centers as possible, will be connected to the Grid.
- by 2002, school leavers will understand ICT, based on its inclusion in the curriculum up to that point. Measures will be in place to assess competencies in ICT.
- by 2002, the UK will be internationally recognized for software development and learning services
- from 2002, governmental, administrative and school communications will be electronic, rather than paper based.

Both the **Scottish and UK Universities for Industry** (UfI) are computer based education programs that are expected to ultimately become the "heart of the Government's vision for lifelong learning." These so-called "Universities" (they are not actually higher education) are built on partnerships between the government and private industry, and they represent the need to connect industry and individual skill needs with learning and training opportunities. ICT will be the cornerstone of its operation. Activities include:

- determining the needs of industry, or "client" groups
- increasing the demand for training through a program of marketing and promotion
- providing information to citizens regarding the services and opportunities at UfI, though traditional media as well as internet-based groups
- using partnerships with industry to create learning programs that adequately match needs to training
- developing needed training programs to fit consumer and client supply and demand; programs customized to industry needs
- ensure that quality of what UfI produces, whereby UfI becomes recognized as a premier source of skilled workforce training and industry partnership

The UfI is intended to work in parallel with the Grid, utilizing the infrastructure and materials that the Grid will establish. In the prospectus for UfI, the architects recognize that information and communications technologies have become essential for a rapidly growing proportion of the workforce and are increasingly important for business competitiveness and individual employability (***Pathfinder Prospectus***, 1998). The program target is that within five years an additional 200,000 people per year will take ICT programs at levels 1,2, and 3.

The UK's UfI has developed into a powerful tool. It already offers approximately 4,400 hours of learning on line and has enrolled about 139,000 users between November 2000 and February 2001. Further, the UfI has contributed to additional skill development ***in*** ICT. Courses for ICT users and for the ICT industry have the highest enrollments. One problem that has emerged is that some of the FE colleges have come to view UfI as a competitor (even though most of the revenue flows to the sponsoring college) and have not been supportive.

3. Advanced ICT Skills

In addition, ***Higher Still*** established a Scottish Group Award in Computing and Information Technology at the Intermediate 2 (16 unit and assessment credits) and higher (20 unit and assessment credits) levels. The content is generic; those completing the program will have a set of practical and vocational skills such as understanding networked and stand-alone systems and their peripherals, knowledge of computer operating systems, and specification of computer software—all intended to prepare them for a wide range of IT occupations.

These programs that prepare people for work in the IT industry are subject to regular examination by Her Majesty's Inspectorate. One aspect of the regular assessments of performance and quality the HMI is a cross-institutional study of good practice by program, and in 1999 they reported on what they had learned about the Computing and Information Technology programs through visits to 31 colleges from 1994 through 1998 (Scottish Executive, 1999). The assessments are quite intense, and Inspectors observe classes, talk with faculty and students, and examine student work and documentation.

Programs ranging from non-advanced certificate programs to higher national certificates and diplomas were available, they found, in 40 of 43 of Scotland's FE colleges. They concluded that vocational skills were not as highly valued by employers as degrees, and thus there was pressure to continue to higher education. They also reported that the increases in applications in many forms of employment suggested a more general development of core IT skills rather than only within the discipline. They said efforts to attract women in IT career fields were inadequate and few colleges were aware of existing marketing materials such as "Women into Computing." The report compliments staff-student relations as exemplary but found too few opportunities for group work and too much emphasis on individual learning.

The study looked closely at the use of assessments and found that formative assessments were used to help students identify areas for improvement and summative assessments to evaluate the effectiveness of their own teaching. The overall Student Unit of Learning Achievement ratio was 75 percent and the Student Program Achievement Ratio was 65 percent. Despite these high figures, they warned that a significant number are withdrawing from programs early and thus not included.

Recommendations included:

- develop staff competencies in the workplace assessment of computing and IT skills

- review the purposes of formative and summative assessments and establish clear policies on re-assessment
- evaluate performance indicators of student achievement to identify actions to improve performance
- promote the review of teaching approaches, drawing on student and peer approaches
- increase the extent and scope of integration of delivery and assessment, both within and across units

4. Financial incentives

One solution to increasing demand is the provision of "Individual Learning Accounts" (ILAs). This is a fund on which any individual can draw to further his/her education or acquire skills. Managed by the nation's two development agencies, the first 100,000 applicant learners aged 18 or over can receive up to about $220 to spend on eligible learning. After that target is met, learners will get a discount on the cost of courses. The assumption was that ICT skills would be a high priority, and this has proven to be the case in the first years.

Some local development agencies have expressed concern that the FE colleges lack sufficient connections to high-tech companies and are too distant from the market to provide the kind of well-trained workers the companies in their regions need and want. This year the Scottish Further Education Funding Council has a small among of money set aside to strengthen connections to employers, but the issue may also be the gulf between the culture of the institutions and the private sector.

5. Local Exemplary Programs

The Scottish Office has already identified several colleges and programs that are effectively implementing ICT in the delivery of services.

- ***Slamannan IT Centre:*** in an area of industrial decline, the learning centre offers a variety of courses, with delivery enhanced by the use of IT. The learning centre is a partnership between Forth Valley Enterprise, Falkirk Council and Falkirk College of Further and Higher Education.

- ***Enterprise Ayrshire:*** Enterprise Ayrshire is an agency, the only agency in Scotland, to bring Cyberskills training courses into the community. Cyberskills is a trademarked series of workshops that offer hands-on experience with developing ICT and the internet.

- ***Glasgow Telecollege Network***: Started in 1997, this broadband communications network links the ten FE colleges, the universities in Glasgow, the BBC, Scottish Enterprise Glasgow, and Learning and Teaching-Scotland. It allows for collaboration in teaching as well as expanded learning opportunities.

- ***Edinburgh's Telford College:*** provides distance learning opportunities wherein students can access educational packages on-line at their local public libraries. Library staff provide on-site technical assistance. This is part of the Open for Learning Initiative.

IV. IT Skill Development in Denmark

Denmark has undertaken a number of initiatives to assess the needs for ICT skills, both at national and regional levels. Forecasts showed an immediate need for approximately 13,000 employees with a diploma at vocational-college level and approximately 40,000 over the next four to five years. Demand for candidates with an academic degree were higher, mainly because of an increased demand for methodological, problem identifying, and problem solving skills linked to ICT development.

- In 1995, the Ministry of Education established for a period of five years the Danish National Centre for Technology-Supported Learning (CTU) to collect and disseminate information about Technology Supported Learning and empowered it to make grants to colleges, organize workshops and seminars, and generally promote the use of IT based learning. In July 2000, CTU was transferred into Learning Lab-Denmark (LLD), a new research-based center that focuses on learning and skills development.

- In August 1996, Grenå Technical College, in co-operation with IBM and Tele Danmark, developed an "IT-College Denmark" as a model for ICT innovation in education. This project has been supported and recognized as a leading innovator by The Danish Centre for Technology Supported Education.

- In 1997, the Ministry of Labor commissioned a qualitative study to Danish Technological Institute on the effects of ICT on work organization practices, with a focus on high performance organizations and a subsequent renewal of the skills base for a non-academic workforce.

- In 1998 the Ministry of Education and Ministry of Research contracted with the Danish Technological Institute for a national study of industry needs, with a primary focus on the needs in the IT sector. This was a background study to an initiative later implemented—the establishment of the National ICT University.

- At the end of 1999, the Danish e-business Initiative begun by the government, commissioned a study to Danish Technological Institute on the need for e-business related skills and how these needs are met by different educational actors. In general, the study showed that very few technical and commercial colleges have taken specific initiatives addressing the needs for new skills relating to e-business. The situation is not quite the same at academic levels.

A number of regional studies have been initiated by local labor market authorities to govern policies that can aim at matching supply and demand. For meeting the demand for ICT skills among skilled workers, informal learning and supplier training is the most important route for people already in jobs. It is a common criticism from industry that they have difficulties assessing the qualifications of students from degree programs offered by vocational colleges and schools of commerce, because programs are short lived and contents are not described in ways that can easily be understood.

Furthermore programs are criticized for not focusing sufficiently on problem solving and methodological skills in the curricular foundation.

The so-called “PC Driver’s License,” a European standard has been an immense success as an introductory basic skills ICT, is particularly useful in the service sector. Companies from the production sector seem to find the course less relevant. In the surveys and case studies we have conducted—some firms, especially in the manufacturing and graphic arts sectors, have advocated for a similar introductory program for their fields.

In 1996, the Danish Ministry of Education formulated an ICT strategy and action plan that was to govern ICT initiatives concerning the entire education sector. The part dealing with Vocational Education and Training focuses on the following:

- Infrastructure
- Teacher’s qualifications
- New student roles
- Integration in curricula
- Legislative issues including tests, exams and Q-strategy

A. Infrastructure

There is a PC with multimedia facilities for every 2.8 student in vocational colleges. Eighty percent of these PC's have access to Internet. All schools are linked to the nation-wide sector net, a high-speed network used for collaborative as well as administrative purposes. At some schools, however, there are severe problems with accessing the Internet through the sector net.

A number of pilots have been sponsored by the Ministry of Education that focus on the integration of ICT in other curricula and on new pedagogical frameworks. The most important project is KomIT, which was started in 1997. The Ministry target is that by 2001 all schools have teachers who have completed the KomIT training initiative and are able to function as local support nodes at their schools.

For the past six to seven years, the tendency has been to integrate ICT in the subject and curricula rather than offering separate courses and modules. This applies to programs in schools of commerce as well as vocational training schools, though it will typically also be possible for students to chose specialties and electives with main emphasis on ICT—for example the PC driver's license or advanced design with CAD/GIS applications for building and construction.

A number of program and pilots have also been supported by the National Center for Technology Supported Education (1995-2000) with a focus on how ICT can be used, for example, in:

- Inter-institutional collaboration to support specialization

- Change in material supply and usage- for example open learning centers or materials on the net to support inter-institutional and project based collaboration
- Teachers' training
- Particular topics (e.g., math, physics, and languages)
- Exams and tests

B. ICT educational programs.

The following provides a short overview of the most important ICT programs offered by technical and commercial colleges.[3]

ICT pilot degree programs

- Digital Media began in January 1999 at three technical colleges, with 20 students at each.
- IT-supported component in the datamechanic education is currently offered at five technical colleges, with 300 students enrolled.
- Media graphic expands the traditional graphic program by placing more emphasis on multimedia components. It was initiated as a pilot from August 1999 with a total of 125 students at five colleges.

Other degree programs - Vocational and commercial colleges

Education	**Supplier**
Commerce & Office with IT	Schools of commerce
Graphics	Technical colleges
Technical assistant	Technical colleges
Datamechanics	Technical colleges
Photographer	Technical colleges
Film, TV, Video	Technical colleges

Further degree programs – approximately two years

Education	**Supplier**
Media coordinator (stopped jan 2000)	Schools of commerce and technical colleges
Media economist (stopped January 2000)	One school of commerce
Economics and Informatics (stopped January 2000	One school of commerce
Multimedia design (stopped January 2000)	One school of commerce
Multimedia designer starts August 2000	Schools of commerce and technical colleges
IT & Electronics Starts August 2000	Technical colleges

[3] The data are derived from a list provided by Confederation of Danish Industry and their branch organization for ICT – ITEK, July 2000.

Part time supply under Legislation of Open Education

Education	Supply
PC drivers license (face to face and distance education)	Technical colleges and Schools of commerce
IT administrator	Technical colleges and Schools of commerce
Datanom (face to face and distance education	Schools of commerce

The Danish Board of Technology was established in 1985 by the Danish Parliament to:

- follow and initiate comprehensive assessments of the possibilities and consequences of technological development for society and the citizen, and
- support and encourage a public debate on technology.

A 1995 amendment extended the board's responsibilities to include:

- follow the development of technology
- carry out research and comprehensive assessment of the possibilities and consequences of technology for society and the citizen
- initiate independent technology assessment
- communicate the results of the work to ***Folketinget*** and to other political decision makers in society, and to the Danish population in order to support and encourage a public debate on technology.

The board is funded by the government each year (10 million DKr $1,259,853) and employs 13 **FTE**. In addition, the board will periodically employ outside consultants for the projects. Eight to ten large projects are decided upon each year. Methods for project research include: expert-oriented technology, single expert analysis, cross-discipline expert group analysis, participatory methods, workshops, conferences, and public date. The board tries to use three different types or methods for each project: expert-oriented, participatory, and public debate. Follow-up and communication regarding the projects involves meetings, publications and briefing papers.

V. IT Skill Development in Canada

Canada's economy is becoming as dependent on ICT as any industrialized nation. The IT sector in 1997 had been growing at a rate of 8.1 percent since 1990 (Lee and Oliver, 1997), with employment in IT software and services growing the fastest. The skill shortage is estimated at 50,000 workers. The major gaps are estimated to be computer scientists, software designers, and systems analysts. As a result, both government-sponsored programs and industry/government cooperative efforts are forming to meet this growing labor force demand. But in Canada there is also a broad-based concern about the quality of the jobs and a fear that without any intervention they will produce low wage "McJobs."

In 1998, ***Industry Canada*** released a report on the knowledge economy called ***Making a Difference*** that called for Canada to "provide access to a world-leading Information Highway Infrastructure and to the learning network" by giving all Canadians between the ages of 15 and 30 IT experience through programs such as SchoolNet Digital Collections and by connecting all schools to the Internet.

In February 2000, the Ministry announced a number of new initiatives for high-tech occupations aimed at supporting the digital economy. A $742 million, the Superbuilding Fund will create more than 12,000 new spaces in IT programs. The Access to Opportunity Program ($228 million over the first three years) is open to electronics and computer programs in the CATs. About $700 million is available in 2000-2001 to develop new IT program standards and to modify or develop new programs. Finally, $5 million is available for distributed learning.

A. Applications of ICT in Education

In 1992, a study by the Association of Canadian Community Colleges (ACCC) on the use of ICT in delivering education and training provided baseline information for assessing progress, and, in 1997, ACCC re-examined the issue (ACCC, 1997). By 1997, 93 percent of college reported Internet access, and were using it for distance learning, to supplement classroom learning, and to streamline administration. About three in eight were offering Internet-based courses but about half were using it. Although distance learning was not new, the study showed that colleges now were extending their reach considerably. The study also revealed that colleges were facing more competition from other training providers. They meet this challenge by trying to offer superior services—for example, courses that allow learners at different colleges to interact.

B. Responses to Skill Shortages

The Canadian Software Research Council (SHRC) and the Human Resources Development Canada sponsor the National IT Youth Internship Program, a six-month internship to help young Canadians enter the IT industry. From September 1999 to

March 2000, the program provided work experience for 100 youths (up to 30 years of age) in a software-related occupation; a follow-on 2000-2001 program is currently being implemented.

An Information Technology Program (ITP) is designed for university and college graduates. The 12-month interactive learning program, which includes a three-month work term, is delivered at colleges and universities across Canada. Emphasis is on the business applications of client/server technologies. Through ITP's business simulation, Millennium Corporation, students work on several IT-related projects as if they were employees of an actual company.

Under SHRC auspices, a Skills Gap Program has also been established to create a nationally accessible learning infrastructure that assists software workers in upgrading and renewing their skills. In cooperation with industry, SHRC seeks to sustain efforts to constantly upgrade the content, context, and delivery processes of IT professionals. Under an Education Program for Software Professionals, courses are taught on a part-time basis. This program is designed to provide software professionals with core knowledge and to prepare them to handle future IT developments. After six completing courses, participants receive a diploma from the University of Waterloo.

Industry Initiatives

Industry is also quite active in sponsoring IT education in Canada. Cisco Systems Canada has an innovative partnership with school districts across the country, while the Cisco Networking Academy program is a cooperative venture among school boards, the Ministry of Education and Cisco. Through this program, high school and college students can prepare for the Cisco Certified Network Associate examination. It is a four-semester program based on the principles and practice of designing, building and maintaining computer networks.

Recruitment from outside Canada is another strategy. The Software Development Worker Pilot project allows highly skilled foreign workers to come to Canada on temporary employment authorization. Since May 1997 nearly 3,000 foreigners and more than 100 Canadian employers have used this mechanism.

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