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Human Resource Development and Planning in the Canadian Software Sector

By

Katie Davidman

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The Training Project

This paper was initiated as part of the Training Project. The Training Project has produced a series of studies, working papers and a synthesis report (listed at the back) that provide an overview of changes in the Canadian workplace, assess the way Canadian employers are training their workers, discuss the effects of changes in the workplace on young people, and reflect upon the emerging training market in Canada and the roles of workers, employers, educators and the government policy framework in adjusting to this emerging landscape.

Within the context of this program of research on employment and training, we wanted to profile an industry that we suspected was experiencing some of the hallmark aspects of working and learning in the "new economy" – such as demand for highly skilled workers, requirement for lifelong learning, non-standard work – and that might feature innovative responses to the demands that this asks of all stakeholders in a human resource development and planning system. Hence, this discussion paper, which focuses on these issues in the Canadian software sector.

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I. Introduction

The purpose of this paper is to attempt to describe the Canadian human resources development and planning (HRDP) system in the software sector. The HRDP system, in the broadest sense, facilitates the meeting of labour supply and demand. When an HRDP system works well, employers are able to recruit the human resources they require, students are able to judge the existence of career opportunities and then find the appropriate education and training to prepare to meet sector labour demand, and workers are able to manage their careers within the sector.

A well functioning HRDP system is integral to the software sector for several reasons. First, unlike some industries that are dependant upon the input of raw materials such as oil or lumber, one of the most important inputs to the success of the software sector is human knowledge, skills, and creativity. Second, demand for human resources in the software sector is high, domestically as well as globally, creating competition for top quality talent. Finally, the software sector is a "new economy" sector, characterized by a particularly strong need for workers to engage in ongoing development of cutting-edge skills, and for an HRDP system that can accommodate individuals whose work opportunities feature non-standard employment contracts and high job mobility.

The HRDP system is made up of a number of interdependent components, grouped into three areas of analysis for the purposes of this paper: (i) the system of education and training that initially prepares students for work in the software sector; (ii) the system of continuous learning that supports the ongoing skill development needs of software workers; (iii) the attraction and retention HR practices of firms, such as pay, support to worker's career development, and professional image.

The HRDP system functions according to the actions of the wide range of players to be found within each of these components of the HRDP system: educators and trainers, employers, governments, and workers, as well as the various associations that reflect the collective representation of these groups, and the cross-representation of stakeholders through networks and alliances.

The description of the software HRDP system in this paper is examined in several sections:

Section II provides a brief history of the development of the software sector, followed by a discussion of definitional and measurement issues.

Section III makes use of the available data on the sector to provide a labour market profile. This covers employment levels, the nature of the employment opportunities and contracts, income, the skills required in the profession, the demographic profile of workers, and the reported shortage of workers to meet industry needs. This section provides the contextual backdrop for an examination of the HRDP system in the following section.

Section IV examines the key components of the HRDP system in the software sector: the education and training system that feeds workers into the sector at both the initial stages and through continuous learning, as well as the role of employers in attracting and retaining software workers.

Two main points about the HRDP system emerge. First, there are number of existing and potential problem areas within the HRDP system in the software sector, around issues of the training provided by the education and training system, the capacity of educational institutions, the quality of career guidance provided to students, unemployed and self-employed contract workers, and the practices of firms in attracting and retaining workers. The lack of adequate labour market information and signals within the sector is one of the major culprits. Second, the stakeholders associated with the various components of the HRDP system have been coming together through stakeholder networks such as the Software Human Resources Council and regional development bodies to pool their respective resources towards solving problem areas within the HRDP system. As a result, many new developments are underway that hold the potential to bring about improvements to the system.

II. The Canadian software sector: history and definition

A brief history of the Canadian software sector[1]

From the 1950s until the 1980s, mainframe in-house computer systems formed the core of activity in the software sector. Manufacturers provided basic system software to government and large corporations, who wrote their own applications under the supervision of the manufacturer. The most common employment opportunities in the sector at this time were for data processors, information systems managers, or individuals capable of developing or servicing computer hardware. The evolution of the sector within this time frame consisted predominantly of the transition from company-crafted computing solutions to single solutions provided by hardware companies in the form of large scale computer applications and on-line computer systems.

The increasing standardization and decrease in price of basic hardware in the 1980s allowed the number of computer end users to increase. This created a strong demand for a wide range of computer programs, and for services to support these growing numbers of users. The separation of software development from increasingly standardized hardware production allowed for the de-coupling of the hardware from the software industries. The software sector then grew in response to demands for desktop software and services to suit a variety of home and office needs. Software development itself underwent change in this period with the increasing adoption of object-oriented programming languages (e.g. C++), the building-blocks of code from which software programs can be developed.

In the early 1990s, the software sector was affected by economy-wide movements towards downsizing and streamlining, at which time many industries began to outsource their previously in-house computer activities. A host of small software enterprises emerged, each attempting to reach the level of sophistication required to compete in the increasing number of specific niche service and product development areas. Demand increased for software that could function on a wide range of operating systems and suit the varied needs of users in the new client/server reality. Desktop computers came to be increasingly connected in a network environment, creating the need for software functioning on multiple platforms connected through local and wide areas networks (LANs and WANs). Software developed to allow a person to perform several different applications simultaneously (multitasking), among increasingly sophisticated programs. The explosion of the Internet and Intranet demonstrated the ability of the software sector to create numerous new office management, communications, educational and recreational services.

The pervasiveness of the software sector in our daily lives continues to expand as computer use increases and expands, and as technology drives all kinds of other new developments which require the use of software. For instance, the increasing power of computer chips has created an

[1] The early history in this section draws heavily from a publication by the Science Council of Canada (1992).

ongoing demand for software capable of harnessing the new potential capabilities, such as improvements to global communications. The convergence between software and telecommunications technologies is creating the ability for people to access the Internet from their home television sets and telephone lines. The embedding of software into manufactured products is making our home appliances, automobiles, and personal information increasingly computerized.
All of these developments and numerous others of this kind point to a story of vibrancy in the software sector that has shown no signs of subsiding (assuming the Year 2000 problem does not create insurmountable glitches).

Defining the software sector in 1998

Given the tremendous change that the software sector has undergone historically, it is no wonder that there is currently no one standard way of defining its work or occupations. However, the lack of a standard, shared definition of the sector makes it difficult to characterize the dimensions and needs of its labour market. A consensus on how to approach the sector definitionally would constitute an important step towards human resource planning and development for the sector. This section undertakes a brief review of the definitions most frequently employed in current studies of the sector.

It is generally understood that the software sector encompasses a variety of types of work that are carried out both within a software *industry*, consisting of software firms such as Corel or Cognos, and *in-house*, within non software-related office buildings and manufacturing plants throughout the economy.

The Software Human Resources Council divides activity within the software *industry* into three sub-sectors (SHRC 1995a and 1995b), as was first suggested in a report on the software sector commissioned by Employment and Immigration Canada (1992).

- *software product development* includes establishments who develop software products for sale to outside organizations and consumers, such as systems software packages, accounting and financial software, manufacturing software, administration software, user tools, and training and games software.

- *the embedding of software* refers to the process by which software is inserted into products such as calculators, electronics, commercial and industrial telecommunications equipment, computer systems, radar equipment/related devises, sonar/echo sounding/related devices, and telephone apparatus.

- *software-related services* includes those who provide software-related services for use outside the firm, including professional services, system integration services and software maintenance.

However, it should be noted that this definition is not applied uniformly in studies on the industry. For instance, Statistics Canada's annual report on the *Software Development and Computer Services Industry*, which is one of the main sources of available data on the industry, does not isolate "embedding" as a sub-sector, includes several other hardware-related sub-sectors,[2] and divides the services subsector into two categories: professional services and processing services. Detailed versions of the definitions used by the SHRC (1995b) and Statistics Canada (1998) are presented in Appendix 1. Despite the use of sub-sectors in industry definition, there are almost no recent labour market data available at the sub-sector level,[3] although the different subsectors likely operate under different labour market contexts with varying skill requirements.

The *in-house* component of the software sector is composed of people in software occupations who work in non-software industries throughout the economy. For example, about one half of computer programmers and systems analysts (approx. 130,000) were spread across the finance, insurance, and real estate industry; manufacturing; government services; communication; trade; community services; utilities; and transportation and storage in the fourth quarter of 1997 (see Table 2.1) (Gower, 1998a). The remainder were working in business services (where the software *industry* is located). Hence, the many reports that focus on employment within the software *industry* are actually missing a lot of software-related labour market activity.

Hence the software sector can be examined from an economy-wide perspective (across all industries) as well as by a focus on software-related firms. Some reports combine the two sources of information. Industry Canada's annual statistical review on the industry (1998a) presents statistics on the number of establishments in the industry from Statistics Canada's Software Development and Computer Services Industry report (1998), but presents employment statistics from the Labour Force Survey which would include employees well beyond those working in

[2] The hardware-related subsectors make up only 18 percent of industry revenue. Future revisions to the Statistics Canada Standard Industrial Classification system will allow for a software industry to be more clearly defined in separation from its hardware components. (see Appendix 2). This would likely allow for a more accurate sampling of firms that are strictly software related.

[3] According to information from 1994, services was the largest employer of software workers, followed by the products sub-sector and the embedded subsector (SHRC, 1995a). The products sub-sector is the only one for which we have more current detailed information, showing that in 1995 it was comprised of 5,330 firms employing 26,415 people and generating total revenues of $2.7 billion (Kormylo, 1998). This information is based on Industry Canada's new Business Register of Information Technology Enterprises database, which will afford analysis by other sub-sectors, as of yet unpublished. Otherwise, the only information currently available by sub-sector is on revenues: in 1995-96 the professional services sub-sector earned the greatest percentage of total industry revenue, followed by processing services and products development (Statistics Canada, 1998).

these establishments.

The economy-wide or sector perspective has the result of getting a more complete picture of total employment and labour market activity. This is captured through something like the Labour Force Survey that can count all the people working in software-related jobs. But, just as there has been no consensus across research studies on how to define the component parts of the software sector, there is no standard way to define the occupations which constitute software jobs.

Table 2.1 Employment of computer programmers and systems analysts in selected industries, fourth quarter, 1997

Industry	Number of programmers and analysts
All industries	267000
Business services	134000
Finance, insurance, and real estate	30100
Manufacturing	25700
Government services	24300
Communication	15600
Trade	14400
Community services (includes education, health, and social services and religion)	11100
Utilities	4300
Transportation and storage	3000

Source: Gower, 1998a, based on data from the Labour Force Survey

Drawing from the standard lists of occupations used by Human Resources Development Canada (HRDC) and Statistics Canada, people would probably agree that many "mathematicians, systems analysts, and computer programmers" could be considered to be doing software-related work, and would hence be relevant to a labour market characterization of the software sector (this is the occupation shown in Table 2.1). But it is less clear which other occupations ought to be ascribed to a labour market characterization of the software sector. A close examination of the occupational profiles produced by HRDC (HRDC, *Job Futures*, 1997) reveals that about one-quarter of "other engineers" are computer engineers, just over one half of "managers in engineering, architecture, science and information systems" are information systems and data processing managers, and 34 percent of "civil, mechanical, electrical, and chemical engineers" are electrical and electronics engineers. Perhaps these workers could all be ascribed to the software sector (using the data coded to each of these occupations in *Job Futures*, inclusion of these segments of workers over and above the 167,000 "mathematicians, systems analysts, and computer programmers" would have added close to 70,000 workers in 1996). There might be other occupations with software-related workers – this is the kind of definitional work that has yet to be done within the sector.

The lack of definition in this area presents several limitations to labour market analysis of the sector. If the occupations are not defined, we tend to underestimate the numbers of workers in the software labour market, by counting only those in the industry, or only those who are programmers and systems analysts. Second, occupational information is important for examining the skill demands of a sector, and for signaling to young people making career choices what kinds of occupations they can consider.

There are currently two initiatives underway that ought to improve to the current situation around software occupational definitions. One is an initiative by which the list of occupations used by Statistics Canada (the Standard Occupational Classification system) has been revised to more accurately reflect the modern economy (it is now almost identical to the list currently used by HRDC). In 1999, data will begin to be collected according to the revised list, which embodies an improvement in occupational categories specific to the software sector over the previous list (see Appendix 2). The second is an initiative called the Software Occupational Skills Profile Project, whereby the SHRC, HRDC, the Canadian Information Processing Society (CIPS), industry representatives, and academics are cooperating to try to better define software occupations. This team hopes to find ways to make the HRDC list of occupations more relevant and useable by industry representatives, policy-makers and software career seekers (See section IV).

Conclusion

Defining what kind of activity constitutes work and occupations in the software sector is a crucial prerequisite to the development of high quality labour market information on the sector. Inevitably, advocating one standard set of definitions for the sector involves grafting somewhat artificial constructs onto what is really a dynamic area of activity with boundaries that might flow beyond the constructs we create (for instance, with the convergence of hardware and software in communications cables, we risk distorting things if we call for the analysis of hardware and software to be separate). However, our current market system is dependent upon information signals to function smoothly, and the kinds of signals required for labour market planning are those which embody information about the numbers of workers, and the kinds of skills and training in demand. This kind of information is transmitted through categories of work/occupations, which are connected to education and training programs to which industry can attach signals such as certifications. These categories, then, become an important part of the overall human resources development and planning system.

We return again in Section IV to the importance of information signals as one of the crucial pieces of a well functioning system of human resource development and planning for the software sector. We turn next to a description of the software labour market with the labour market information that is available, within the currently limited definitional parameters.

III. Occupations, Workers, and Skills in the Software Sector

The purpose of this section is to undertake a statistical examination of the nature of work and workers in the software sector. This descriptive presentation will be followed in the conclusion to this section by a discussion of the implications for human resources development and planning for the sector.

A note on measuring the software sector

It should be noted that several factors limit our ability to obtain accurate labour market indicators on the software sector. As was discussed in the previous section, the scope and accuracy of software sector labour market information is limited by definitional problems. It should be noted that the statistics used in this section are from both industry-based and occupationally-based data, depending on availability. Measurement abilities are further limited by the existence of rapid growth and change within the sector, which ensures that software sector related statistics are outdated by the time they are in print. This makes it difficult to provide accurate estimates of indicators which normally facilitate human resource development planning such as information on the specialized skills in highest demand. Finally, measurement is limited by the dearth of detailed data. For instance, while skill needs and labour demand in the sector likely vary across industry subsectors, there are virtually no labour market data at this level of detail that are collected on a regular basis.

Employment

How many people are employed in the software sector? The answer to this seemingly straightforward question varies, depending upon the data sources and methodologies used. Tables 3.1A and 3.1B show the varying numbers that are available from government statistical sources on the *industry*, as well as for two software related *occupations*. The lowest figure cited, 85,719 in 1995-96, is from Statistics Canada (1998), which reports on employment in the software *industry* excluding the self-employed (Table 3.1A). The figure 137,300 (in 1996) is from an Industry Canada study, which also captures employment in the software *industry*, but includes self-employed workers (Table 3.1A). Finally, Statistics Canada provides an aggregate measure of employment for two software *occupations* (across industries) – computer programmers and systems analysts, including the self-employed -- which results in the largest (and most recent) estimate of 267,000 workers in the fourth quarter of 1997 (Table 3.1B).[4]

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[4] By the second quarter of 1998, this figure had increased to nearly 280,000 (Gower, 1998b).

Table 3.1A Employment in the software *industry*

	Employment[1]		
	1992	**1995/1996** [2]	**% change, 1992-1995/1996**
(1) Statistics Canada	66525	85719	29
(2) Industry Canada	72021	137300	91.6
(3) All Occupations in the Economy:			
Employees Only	10905800	11369900	4.3
Employees + self-employed	12841900	13676200	6.5

Notes:
[1] See text for explanation of the differences between the figures in the two sources presented
[2] The latest available figure from Statistics Canada is 1995-96, while the figure from Industry Canada is for 1996. The percent change in the following column is calculated using the latest available figure in each case.
Sources:
(1) Statistics Canada, 1998, *Software Development and Computer Services Industry*, 1995-96.
(2) Industry Canada, 1998a, *Information and Communication Technologies (ICT) Statistical Review, 1990-1996.*
(3) Source: Statistics Canada, Labour Force Survey. The first row under "All Occupations..." calculates employment growth for employees (excluding the self-employed) between 1992 and 1995 to make it comparable to the Statistics Canada source, while the figure in the row following it is calculated including the self-employed from 1992 to 1996 to be comparable with the Industry Canada data.

Table 3.1B Employment in the software *occupations:* computer programmers and systems analysts

	fourth quarter, 1997	**% change, 1992-1997**
Computer programmers and systems analysts	267000	92
Other scientific and technical occupations	375000	8
All occupations	14032000	9

Source: Gower, 1998a

What is most striking about all these employment figures is the extent to which they have exhibited growth over the decade, compared to other occupations. Even the most conservative estimate of growth, 36 percent over 1990/91-1995/6 (which is lower in part because it excludes the self-employed who we will see later have grown relatively substantially over this period), by far outstrips average employee growth of 4.3 percent over this period. Most other estimates of software employment growth over the 1990s are in the range of 90 percent.

Employment in the software sector has also grown strongly relative to employment in other IT sectors. A study by Industry Canada (1998a) shows that the computer and related services industry is the largest employer out of eleven information and communication technology industries, and has been by far the fastest growing among them (Table 3.2). The study by

Table 3.2 Employment in selected Information and Communications Technology (ICT) industries

Industry	1990	1996	% change, 1990-1995
Record player, radio, and television receiver industry	2628	1068	-59.4
Telecommunication equipment industry	14861	20075	35.1
Electronic parts and components industry	14963	17992	20.2
Other communication and electronic equipment industries	26312	17911	-31.9
Electronic computing and peripheral equipment industry	12159	16658	37
Electronic and other office, store and business machine industries	4037	2706	-33
Indicating, recording and controlling instruments industry	11452	10139	-11.5
Other instruments and related products industry	6882	8996	30.7
Total ICT Manufacturing	93294	95475	2.3
Broadcasting*	53973	56500	4.7
Telecommunications Carriers*	142157	128700	-9.5
Computer and Related Services*	**71660**	**137300**	**91.6**
*Total ICT Services**	267790	322500	20.4
Total ICT	361084	417975	15.8

Notes: * Includes full-time, part-time, and self-employed, from the Labour Force Survey. The other figures are full-time equivalent figures, from the Survey of Manufacturing. Underlined figures are Industry Canada estimates.
Source: Industry Canada, 1998a.

Statistics Canada (Gower 1998) shows particularly strong employment growth amongst computer programmers and system analysts relative to other scientific and technical occupations (Table 3.1B).

Employment by region

Tables 3.3A and 3.3B show that both the software industry and software occupations tend to be clustered in the bigger cities of Ontario and Quebec, followed by Alberta and British Columbia. The cities employing the largest numbers of programmers and systems analysts in 1997 were Toronto and Montreal. The cities with the largest increase in employment over 1992-1997 were Vancouver, followed by Montreal, Edmonton, and Toronto. The city with the largest numbers of software workers as a percentage of the employed was Ottawa-Hull.

Table 3.3A Regional distribution of the software *industry*, 1995-96

Province	Firms (number)	Firms (share)	Revenue $'000,000	Revenue (share)	Employees (number)	Employees (share)
Newfoundland	58.4	0.4	74	0.7	523	0.6
P.E.I.	19	0.1	11	0.1	103	0.1
Nova Scotia	170	1.1	88	0.8	763	0.9
New Brunswick	156	1	97	0.9	816	1
Quebec	2 841	18.6	1 935	17.5	18 508	21.6
Ontario	7 260	47.4	6 700	60.7	45 973	53.6
Manitoba	237	1.5	112	1	1 075	1.3
Saskatchewan	191	1.2	193	1.7	1 394	1.6
Alberta	2 091	13.2	646	5.8	6 014	7
B.C., Yukon, NWT	2 356	15.4	1 190	10.8	10 550	12.3
Canada	15 307	100	11 045	100	85 719	100

Source: Statistics Canada, 1998.

Table 3.3B Regional distribution of software *occupations*: computer programmers and systems analysts

	Employment, fourth quarter 1997 number '000	% change, 1992-1997	% of employed
Canada	267.1	92.3	1.9
Atlantic	7.6	56	0.8
Quebec	75.6	81.8	2.3
Ontario	122.9	90.5	2.2
Manitoba	6.9	86.9	1.3
Saskatchewan	4.3	112.7	0.9
Alberta	25.4	100.8	1.7
British Columbia	24.5	155.3	1.3
Selected census metropolitan areas (CMAs)			
Vancouver	18	179.4	1.9
Montreal	53.9	120.1	3.4
Edmonton	9.1	110.8	1.9
Toronto	70.2	104.2	3.1
Calgary	14.1	92.3	2.9
Ottawa-Hull	28.8	84.4	5.3
Winnipeg	5.8	72.4	1.6
Kitchener-Waterloo	4	44.8	2
Quebec	7.7	3.5	2.4
Hamilton	5.2	2.8	1.6
London	2.8	-4.9	1.4
Total CMA	238	92.4	2.6
Other urban	9.9	118.3	0.9
Rural	19.2	80.6	0.5

Source: Gower, 1998a

Labour market context

What follows are a few descriptors about the software sector that sets human resources planning and development into the market context in which it operates. What these indicators reveal is a fast growing, dynamic, globally competitive sector, made up largely of small firms.

Growth and Dynamism

Strong employment growth in the software sector has already been described. Table 3.4 shows that the software industry has also experienced rapid growth in revenues over the decade, and that the number of firms in the sector grew by 40 percent between 1990 and 1996.

This rapid growth is accompanied by dynamism. The fast pace of tech change drives fast product cycles and can change the nature of a firm's products and services over relatively short time periods. A survey undertaken by the Software Human Resource Council (SHRC) in 1994 asked firms about their activities over a three-year period, and found that it was not uncommon for firms to change their primary area of activity from one software subsector to another as market needs and their area of expertise changed (SHRC, 1995a). We will also see in the upcoming section on the nature of work in the sector that workers tend to join and leave employers at a relatively frequent rate, another indicator of sector dynamism.

Table 3.4: Revenue and firm growth in the software industry, various sources, selected years from 1990-1996.

	1990	**1995**	**1996**	**% change**
Revenue		billion $		
(1) Statistics Canada *	5.8	11	n/a	89.7 (1990-95)
(2) Industry Canada	8.3	14.3	15.4	85.5 (1990-96)
No. of Firms				
(1), (2) Statistics Canada and Industry Canada	10 924	15, 307	16 300**	40.1

Notes: * This survey reports fiscal figures. ** Underlined figures are estimates.
Sources: (1) Statistics Canada, 1998, *Software Development and Computer Services Industry*, 1995-96.
(2) Industry Canada, 1998a, *Information and Communication Technologies (ICT) Statistical Review, 1990-1996.*

Small Firms

Firms in the software industry are generally small, both in the revenue they generate and in the number of people they employ. The SHRC reported that in 1994, 76 per cent of firms in the software industry employed fewer than ten employees. According to Statistics Canada data, the average number of employees per firm is 10 or under in firms up to revenue sizes of under $2 million, which covers 14,725 of 15, 307 (or 96 percent) of firms. One third of employees are in these firms. The remainder of employees are in firms with budgets at or over $2 million, which employ an average ranging between 30 - 300 employees each. (Table 3.5). Workers in the software industry are more likely than the average worker to be in a small firm: in the economy overall, only 20 percent of employees are in firms with twenty or fewer people (Statistics Canada, 1995).

Table 3.5 Size of firms

	Total	**Less than $250,000**	**$250,000-499,999**	**$500,000-1,999,999**	**$2,000000-4,999,999**	**$5,000,000-9,999,999**	**$10,000000 and over**
Firms							
Number	15307	12544	994	1187	338	114	130
Share	100	81.9	6.5	7.8	2.2	0.7	0.8
Employees							
Number	85719	12618	4055	11755	10271	8047	38973
Share	100	15	4.7	13.7	12	9.4	45.4
Employees per firm	6	1	4	10	30	71	300

Source: Statistics Canada, 1998.

Global Context

Software is a global growth industry. In 1995 the packaged software market in OECD countries was worth US $88 billion, and the IT services market was worth US $161 billion, with the latter growing at an average annual rate of 10 per cent since 1987. In 1995, Canada had the 7th largest world demand share of this packaged software market (after the United States, Japan, Germany, the United Kingdom, France, and Italy), and the 6th largest world demand share of the market for IT services (after the United States, Japan, Germany, France, and the United Kingdom). Canadian market growth rates for packaged software and IT services are among the highest in the OECD area (OECD, 1997).

The global nature of growth of the software sector has translated into global demand for talented software professionals. A recent publication from the American Department of Commerce (1997) cites several studies which report a worldwide shortage of IT workers: the National Software Alliance and the Information Technology Association of America estimate that there are between 150,000 -190,000 vacancies for qualified IT workers in the US alone. The Department of Commerce (1998) has more recently projected that demand for computer scientists and engineers, systems analysts, and computer programmers will average 137,800 per year between 1996 and 2006 -- a total of over 1.3 million.

The available supply of software labour is also fairly global, indicated by the fact that software workers have come to Canada from places as diverse as India, China, Taiwan, Hong Kong, France, Romania, England, Sweden, Mexico, the United States and the Ukraine (Citizenship and Immigration figures reproduced in the Ottawa Citizen, Hill, April 16,1997). India in particular, produces about 55,000 programmers and engineers every year (Immen, 1998).

The nature of work in the sector

Tables 3.6A and 3.6B show that the majority of workers in the software sector have full-time work, with the bulk of workers attached to an employer (as opposed to being self-employed). However, what also stands out from these tables is the increasing proportion of self-employment in the sector. Self-employment tripled amongst programmers and analysts over 1992 to 1997 (Table 3.6A), growing from 12 percent of total employment to 22 percent (Gower, 1998a). Within the industry (Table 3.6B), self-employment grew by an annual average rate of 13 percent from 1990 to 1996, representing 30 percent of all employment in the sector in 1996. Table 3.6B also shows that part-time employment has been growing at the same rate as self-employment, although the actual numbers employed part-time are smaller than those who are self-employed.

Table 3.6A Self-employment in software *occupations:* programmers and analysts, fourth quarter 1997

Occupation	**1992**		**1997**		**% change**
mathematicians, system analysts and computer programmers	number	share (%)	number	share (%)	
Self-employment	17000	12	58000	22	241.2
Total employment	139 000	100	267 000	100	92

Source: Gower, 1998a.

Table 3.6B Employment status in the software *industry*

	1990	1992	1996	average annual growth rate, 1990 - 1996 (%)
Total Employed	71700	72100	137300	11.4
Full-time				
number	66000	66100	125 300	11.3
share	92%	92%	91.3%	
Part-time				
number	5700	6000	12 000	13.2
share	8.0%	8.1%	8.7%	
Self-employed*				
number	19600	18200	40700	13
share	27.4%	25.3%	29.6%	

Notes: * Note that the self-employed can be either full-time or part-time.
Source: Industry Canada,1998a, *Information and Communication Technologies*

The significant proportion of self-employed in the sector, many of whom would likely be working on contract, may help to account for the relatively high job-turnover exhibited in the form of shorter than average job-tenure (Table 3.7) in the sector. Job tenure figures for the software industry as well as for two software related occupations show that the largest proportion of workers in the software *industry* (41 per cent) have job tenure of 1-5 years, which is above the average for the overall economy (29 per cent). However, the figures also show that workers in the software industry are significantly less likely than the average to have tenure beyond five years, and are significantly more likely than the average to have jobs with tenure of one year or below. That there is a relatively significant proportion of workers in the software industry who experience job changes frequently throughout their careers is further suggested by a study by Statistics Canada which shows that in the fourth quarter of 1997, 30 percent of computer programmers and systems analysts had been in their current job for one year or less, compared to 18 percent in other scientific and technical occupations (Gower, 1998a).

Table 3.7 Job tenure in the software industry and occupations, 1996.

	Total Employed	1-12 months	1-5 years	6+ years
Occupations			%	
Managers in science and engineering	51800	13.4	28.6	58.1
Mathematicians, systems analysts and computer programmers	202600	24.5	33.9	41.7
Industry				
Computer and related services	137000	32.8	40.7	26.4
Economy Aggregate	13676000	21.9	28.5	49.6

Source: Labour Force Survey

Short job tenure could reflect the fact that employers prefer to hire employees on short term contracts. Other reasons for relatively short job tenure could include job switching as a result of high labour competition, births and deaths of firms within the industry, and burn-out from stressful jobs. There is virtually no hard evidence on these latter indicators,[5] and recent evidence on the extent of contract work within the sector is sparse and difficult to interpret. Most reports use different (and usually not explicit) methods for reporting contract work, making figures across reports incomparable, and making it difficult to get an overall sense of its incidence.

In 1994, the SHRC found that, depending on the subsector, between 45 percent and 62 percent of software employers were contracting out for between 14 percent and 30 percent of their work (Table 3.8). This suggests that a significant proportion of employers were contracting out for work, although it does not tell us the proportion of workers affected.

[5] An *Ottawa Business Journal* article featured an unpublished study by Linda Duxbury, Carleton University, of white collar workers at several local high-tech firms, which traced the work and family lives of over 700 Canadian couples over 3 years. The findings were that 80 percent worked overtime, at least four nights a week (Logan, 1997). This is in contrast to data on computer programmers and systems analysts from Statistics Canada, which shows that they were working about 40 hour workweeks, the average for occupations in their field. It is possible that there is significant variation within different parts of the sector, or among different occupations within the sector.

Table 3.8 Amount and proportion of work contracted out in the software sector by subsector

	product	embedded	services	in-house
% of firms which contracted out	45	57	45	62
% of work contracted	14	17	23	30

Source: Software Human Resources Council, 1995 .

More recent studies have been on the entire IT sector (not exclusive to the software sector, although they would include the software sector). A CATA Alliance survey revealed that of 81 per cent of high technology firms that were expecting to hire within the next six months, 20 per cent of new hires would be for term contract positions, and six percent would be for external consultants (CATA Alliance and Angus Reid, 1997).

An Industry Canada study showed that 12 percent of highly-skilled workers in the IT sector were on contract, but this survey counted only employees, and omitted self-employed people working on contract within the sector (Industry Canada, 1998b).

Unemployment

The unemployment rate for computer programmers and systems analysts in the first two quarters of 1998 was around 2 percent, less than one quarter the rate for the overall labour force, and about one half the rate of other scientific and technical occupations (Gower, 1998b).

Income

It is hard to get complete information on the incomes of software workers because there are so many factors involved in earnings, including wages, benefits, and incentives.

Compared to the economy-wide average wage, the data show that workers in the software industry have earned high salaries that have been growing at a relatively high average annual rate. Between 1990 and 1996, the earnings of workers in the software industry grew at an annual average rate of 3.5 percent, compared to 2.5 percent in the economy overall, from a weekly rate of $677 in 1990 (compared to $505 in the overall economy) to a weekly rate of $830 in 1996 (compared to $586 in the overall economy) (Table 3.10A). If fifty-two weeks of employment are assumed at the 1996 weekly rate of $829.90 for software industry workers, this translates into a $43,155 annual salary, compared to the occupational average of $30,475 (at the weekly rate of $586.06).

Table 3.10A Average weekly earnings (including overtime), 1990 - 1996.

	1990	**1996**	**Annual average change, 1990 to 1996, (%)**
Software Industry	$667.03	$829.9	3.5
@ 52 weeks	$34,686	$43,155	
All Industries	$505.14	$586.06	2.5
@52 weeks	$26,267	$30,475	

Source: Statistics Canada, 1996. Annual Estimates of Employment, Earnings and Hours. Cat no 72-F0002.

However, when the earnings of computer programmers and systems analysts are compared to the earnings of workers in other scientific and technical occupations, the wages of software workers are about average, or even slightly below average (Gower, 1998a and b) (Table 3.10B).

Table 3.10B Average earnings of computer programmers and systems analysts compared to other scientific and technical occupations, second quarter, 1998.

	Computer programmers and systems analysts	**Other scientific and technical workers**	**Canadian workforce**
Weekly	$863	$894	$583
@ 52 weeks	$44,876	$46,488	$30,316

Source: Gower, 1998b

Another publicly available source of information on salaries is Robert Half International Inc., a staffing agency and computer consulting firm that provides an annual starting salary guide for a series of IT jobs based on surveys of chief financial officers and other senior executives, and on the expertise of their staffing and recruiting managers across Canada.[6] A sample of the starting salaries for 1998 are provided in Box 3.1. The salaries mostly range above the occupational average outlined in the previous paragraph.

[6]There are a number of other salary surveys on the software sector undertaken by large private sector firms (e.g. Hay Management Consultants, KPMG, Wynford Group), but they are not generally publicly available without payment of a substantial fee, so were not consulted for this report.

Box 3.1: **Starting Salaries of Software Workers**, **1998**		
	Small Firm (less than 50 staff)	Large Firm
IS Director	$55,000 - $70,000	$84,000 - $108,500
Sr. Systems and Programming Manager	$68,000-$90,000	n/a
Systems and Programming Manager	$62,000 - $80,000	$65,000 - $85,000
Systems Analyst	$40,000 - $56,000	$47,000 - $59,000
Programmer	$26,000 - $34,000	$31,000 - $37,000
Computer Operator	$28,000 - $36,000	$27,000 - $37,000
	Any Size Firm*	
Managing Consultant	$60,000 - $89,000	
Senior Consultant	$55,000 -$68,000	
Software Engineer	$45,000 - $68,000	
Systems Architect/Designer	$65,000 - $87,000	
Network Architect/Des	$55,000 - $77,000	
Relational Database Analyst	$50,000 - $69,000	
LAN/WAN Specialist	$45,000 - $68,000	
Network Administrator	$35,000 - $50,000	
Internet Programmer	$35,000 - $55,000	
Help Desk Support	$29,000 - $39,000	

*mostly companies providing consultation and/or vendor products and services

Source: Robert Half (1998)

It should also be noted that the significant proportion of self-employed workers in the sector are likely to be accepting contracts or project-based work for professional fees, which tend to be higher than hourly salaried fees, in part to cover non-salary benefits such as pensions, dental and health insurance, and vacation.

Although the salaries (and probably total earnings) for software workers are about average if not above average depending on one's benchmark within the Canadian context, there has been much discussion about whether Canadian wages are competitive with those in the US. For instance, Box 3.1 shows that a Canadian senior manager of systems and programming in a large firm would be earning between $68,000 and $90,000 ($Cnd), and the same salary guide shows that an American in the same position would be earning $72,000 - $92,000 ($US). This kind of comparison however requires a comprehensive analysis of earnings taking into account income tax rates, exchange rates, and quality of life factors. Without this kind of comprehensive comparative analysis, the actual difference between these wages cannot be fully interpreted.

There is very little publicly available information on the availability of benefits and incentives in the sector. An overall impression can only be gained from various media and industry association articles. According to a survey of 240 firms done for the Canadian Advanced Technology Association (CATA Alliance), 79 percent of high technology companies were paying performance-based incentives in 1996, up from 70 percent two years previous (Hill, May

26,1997). An article in the *Ottawa Citizen* recently featured software jobs with generous stock-option packages, and regular pay increases, as well as workers with skills that are in high demand fetching signing bonuses of between $15,000 - $25,000 (McIntosh,1997). But, this might or might not be representative of the sector.

Demographic profile

age of software workers

Table 3.11A Age of workers in the software industry and various software occupations, 1996

	all ages	15-24 yrs	25-34 yrs	35-44 yrs	45-54yrs	55+ yrs
Managers in science and engineering	51800	n/a*	24.9	42.1	24.9	6.6
Mathematicians, systems analysts and computer programmers	202600	9.9	41	33.8	12.6	2.7
Computer and related services industry	137000	11	41.2	32.4	11.9	3.6
Economy aggregate	13676000	14.9	26.5	28.3	20.6	9.7

Notes: * the number is too low to be statistically significant
Source: Labour Force Survey.

Table 3.11A provides information on age cohorts of workers in several occupations for 1996 from data collected by the Labour Force Survey, and Table 3.11B provides more recent figures from Gower (1998) for programmers and systems analysts. The feature which stands out most from these tables is the below-average proportion of "youth" (aged 15-24) in software occupations, given the youthful image of the industry often portrayed in the media. This is likely due to the relatively high degree of education/skills training and/or experience required to work in the sector.
However, workers in the software sector tend to be younger than workers in all other jobs when the remaining age cohorts are considered. The bulk of workers in the software industry are in the 25-44 years age cohort, and the proportion of those aged 25-34 is particularly high compared to the economy-wide average. Also, the proportion in the two highest age cohort categories is relatively low (although managers aged 45-54 years are the exception, likely because of the greater experience required in this occupation). In part, the relatively small numbers of workers in the sector in the highest age cohorts might reflect the fact that the first generation of computer professionals are now only in their late forties.

Table 3. 11B Age profile of computer programmers and systems analysts compared to other scientific and technical occupations, and all occupations, fourth quarter, 1997.

	Computer programmers and systems analysts		Other scientific and technical occupations		All occupations	
	% in 1997	**% change, 1992-1997**	**% in 1997**	**% change, 1992-1997**	**% in 1997**	**% change, 1992-1997**
All Ages	100% = 267,000	92	100% = 375,000	8	100% = 14,032,000	9
15 to 24	8	99	8	46	14	-2
25 to 34	41	66	30	-12	26	-2
35 to 44	34	113	33	18	29	16
45 +	18	131	28	14	31	20

Source: Gower, 1998a.

However, this evidence on the relatively small proportion of workers aged 45-54 years and 45+ years could lend support to the image that sometimes emerges around the software sector, that older mid-career workers are shunned in favour of younger workers. However, Table 3.11B shows that the highest rate of growth in employment in these software occupations over the last 5 years can be attributed to the group aged 45+ (131 percent), followed by growth for the 35-44 age group (113percent). While some of this growth can be attributed to the aging of the workforce, it is particularly strong in these occupations compared to all occupations, including other scientific and technical occupations.

Gender

Data on the gender composition of software related occupations is presented in Table 3.12. In each of the software-related occupations listed, there is below average representation of women (the economy-wide average is presented in the last row).

Part of the reason for the low proportion of women in the software sector is the relatively low representation of women in the educational "skills pipeline" that supplies this sector compared to the representation of women in all fields of study (Table 3.12B). Some measures are being taken to address the gender gap in software-related educational programs. They include mentorship and on-line guidance programs, as well as career counselling initiatives. These initiatives are often targeted at young women in high school, with the intention of countering sexist stereotypes and of providing mentors to women from a young age (some are featured in Box 5, Section IV).

Table 3.12A: Proportion of women in various software occupations, 1996

Occupation	% women
Mathematicians, System Analysts and Computer Programmers	31
Managers	36
Other Engineers	19
Economy-wide occupational average	45

Source: Human Resources Development Canada, *Job Futures*, 1997.

Table 3.12B Proportion of women in selected educational programs compared to all fields, 1995-96

Level and Field	% Women
Full-Time College	
Math and Computer Science	24
All Fields	52
Full and Part-Time Undergraduate University	
Computer Science	21
Math	41
Engineering	19
All Fields	57
Full and Part-Time Graduate University	
Math and Science	26
Engineering and Science	19
All Fields	48

Source: *Education in Canada,* Statistics Canada, 1998.

Skills, Education and Training Required

As was mentioned in section I, the information on the specific skills needs and educational and training backgrounds that are related to software sector occupations or jobs are ill-defined, and hence the information we have on the skills and training in demand by employers is minimal. This section will take a look at what we know and what gaps are outstanding in our knowledge about the educational attainment of workers currently in the software sector, and at the kind of skills background being sought by employers.

Level of Educational Attainment

Data collected for this paper from the Labour Force Survey show that most workers in the software industry and in software related occupations have either a post-secondary certificate or are university educated. There are many more university-educated workers in the software sector compared to the general working population, and many fewer with a high school education or below (Table 3.13). Statistics on computer programmers and systems analysts collected by Statistics Canada (Gower,1998) also show that employment of people with university degrees in these occupations grew faster than that for those with a post-secondary certificate or no post-secondary certificate (120 percent compared to 80 percent and 55 percent) between 1992 and 1997 (Table 3.13B).

Table 3.13A Educational attainment of workers in the software industry and selected software occupations, 1996.

	Total employed	Completed high school or below	Some post-sec.	Post-secondary certificate	University bachelors degree	University above bachelor
				(percent)		
Managers in science and engineering	51800	8.7	8.1	28.8	34.2	20.1
Mathematicians, systems analysts and computer programmers	202600	8.4	9.6	37.1	33.8	11.1
Computer and related services industry	137000	12.8	10.1	32.6	32.1	12.3
Economy aggregate	13676000	41	9.5	31.3	18.2*	

Notes: * This figure reports the percentage of the labour force for all university.
Source: Labour Force Survey

Table 3. 13B Education profile of computer programmers and systems analysts compared to other scientific and technical occupations, and all occupations.

	Computer programmers and systems analysts		Other scientific and technical occupations		All occupations	
	% of total in 1997	**% change, 1992-1997**	**% of total in 1997**	**% change, 1992-1997**	**% of total in 1997**	**% change, 1992-1997**
Total employment	100% = 267,000	92	100% = 375,000	8	100% = 14,032,000	9
Education						
No post-secondary certificate	15	55	14	-1	48	-6
Post-secondary certificate or diploma	37	80	37	21	33	31
University degree	48	120	49	2	19	22

Source: Gower, 1998a.

Private training institutes are another source of skills training for the software sector. However, there are no comprehensive data sets that depict the numbers of people graduating from private training programs to accept positions in the software sector. One could speculate that this has been a growing source of supply to the sector. The growth of private technology-training institutes such as ITI have been featured in the media (ITI currently graduates about 1,700 each year) (Standen, 1998).

Skills Background

Data from the National Graduate Survey show that workers in the occupation "mathematicians, computer programmers, and systems analysts" in 1992 graduated from a range of educational backgrounds in 1990, the top suppliers being computer science at the college and university levels (Table 3.14). It should however be noted that because this table focuses only on the occupation "mathematicians, computer programmers, and systems analysts," the contribution of educational programs to the training of other software professionals is probably underestimated. Two of the educational programs that are most obviously underestimated are business programs with computer specialities, which are probably the source of training for many information systems professionals, especially IS managers. The new Queen’s MBA for science and technology is an example. A second is engineering educational backgrounds, which are probably much more a part of training for the software sector than is suggested by this table, for software engineering and related occupations.

Table 3.14 Educational training in 1990 of people who were mathematicians, systems analysts and computer programmers in 1992

Program and level of study of 1990 graduates	Percent of mathematicians systems analysts and computer programmers in 1992 with this educational background
computer science, community college	22
computer science, undergraduate	19
math, undergraduate	9
commerce, undergraduate	7
electrical/electronics engineering, undergraduate	5
other engineering, undergraduate	2
computer science, masters	2
commerce, masters	2

Source: unpublished data from the National Graduate Survey.

Anecdotal evidence gathered from media coverage of the software sector and industry association spokespeople suggest that the ideal entry-level hire in the software sector is often a person with a broad set of both technical and non-technical skills. On the technical side, employers usually expect candidates to have applied experience in the use of a particular niche technical skill (such as C++, client/server, networking, Internet/Intranet skills, or multimedia skills), with sharp problem-solving skills and sufficient knowledge and understanding of fundamental technical concepts to be able to adapt to ongoing technological change. On the non-technical side, employers tend to be seeking candidates with skills such as communications (e.g. the ability to communicate technical information to a non-technical audience); business skills (e.g. liaison with clients and perhaps monitoring the growth of the firm); teamwork skills; stress management; creativity; and a willingness to learn on the job. The exact skills required by an employer will of course depend upon the job description and the level of technical know-how required.

A possible shortage of software workers

An aspect of software sector work that flavours current issues around human resources development and planning (HRDP) is the possibility that there is a shortage of skilled workers required for the sector to meet its full potential. The existence and possible causes of a shortage are however difficult to verify statistically, and the science and data required to accurately measure shortage situations are still in development[7]. Ideally, one would be able to capture the

[7] There has been work by Human Resources Development Canada to examine our ability to measure worker shortages, see for example (e.g., Henson and Newton,1996; Henson, Lavoie and Roy,1996).

level and nature of demand for and supply of labour to the software sector, and the incidence and relative impact of vacancies on firms (e.g. the number of vacancies, the length or persistence of vacancies, the proportion of total employment affected by vacancies, and the impact that vacancies have on firms, if any). With all this information, a problematic shortage situation might be one in which firms have vacancies that they are unable to fill over a relatively prolonged period, where these vacancies represent a significantly important input, the absence of which results in negative impacts on the firm. Currently, very few of these ideal shortage measurement dimensions can actually be quantified, which is likely why there remains debate over whether there is an actual software sector labour shortage. However because the potential of a shortage adds a more pressing dimension to work of HRDP in the sector, the possible dimensions and human resource development implications of a shortage are briefly considered here.

Demand for software labour

There is no question that, as was shown earlier in this section, there has been strong and growing demand for software-related labour over the 1990s. Figures for the precise current level of demand are rarely known, and the numbers required for the near future are difficult to project, especially in the fast-paced software sector. However several surveys done over the last few years have indicated that employers were desiring to hire more workers than they could find. In 1994, a Software Human Resources Council survey found that between 30 and 46 percent of software firms surveyed (depending on the sub-sector) had vacancies for an average of three to ten people each (Table 3.15).[8] Six percent of employers surveyed within the in-house sub-sector were experiencing vacancies. The study found that vacancies affected four percent of all jobs amongst the firms surveyed in 1994. If this vacancy rate is applied to the 173,00 employed in the sector at large in that year, it translates into about 7000 vacancies. While the SHRC has done no update of this survey since that time, they estimate that in 1998, between 20,000 to 30,000 positions remain unfilled within the sector.

There are two other sources of information on vacancies that focus on the IT sector at large (which includes software among other information technology industries). A CATA Alliance and Angus Reid email survey of CATA Alliance members revealed that 88 percent of high technology companies reported a skills shortage (CATA Alliance and Angus Reid, 1997). An Industry Canada study of IT firms conducted in the spring and summer of 1997 found that only 35 percent of firms reported vacancies in highly skilled positions, although 77 percent of firms expected their demand for highly-skilled labour to grow over the next two years (Industry Canada, 1998b).

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[8] A similar study done four years earlier for Employment and Immigration Canada (EIC) for the sector study that formed the catalyst for the creation of the SHRC had found that between 22 and 32 percent of firms were unable to find enough software related workers to meet demand (Employment and Immigration Canada, 1992). Some of the same firms were retained in the sample for the later survey.

Table 3.15 Firm with vacancies, 1994

	% claiming shortage	average number of vacancies
In-house	6	n/a
Industry	39	n/a
Products	46	3
Services	37	8
Embedded	30	10

Source: SHRC, 1995

Information on the dimensions of unmet labour demand, such as the persistence or impacts of vacancies, are much less common, but we do have a few indicators. The two rounds of the SHRC survey (the first was carried out in 1992, see footnote 5) would suggest that the vacancy situation had persisted over the four years, and even worsened. Between 22 percent and 32 percent of firms reported vacancies in 1992, while between 30 percent and 46 percent reported vacancies in 1994 (Employment and Immigration Canada, 1992; SHRC, 1994). In terms of impacts, only the initial survey asked firms about the impacts of unfilled vacancies, and found that impacts reported by firms included project delays (reported by 29 percent of firms), lost revenues/contracts/projects (15 percent), delivery schedule delays (11 per cent) and increased workloads (11 percent). The CATA Alliance/Angus Reid email survey found that 25 percent of high-tech firms would be unable to meet demand if they could not fill at least half of their open positions, and another 65 percent would experience a decline in their ability to meet demand.

One of the crucial pieces of information that remains missing is the specific nature of labour demand to fill vacancies within the sector. There is some indication from media and industry-related literature that employers are having more serious vacancy problems for highly educated, especially talented workers with cutting-edge technical skills as well as business/communication and management skills, and several years of work experience. For instance, a recent Industry Canada survey showed that companies were having greater difficulty in recruiting highly-skilled workers to fill professional positions that they were for entry-level positions (Industry Canada, 1998b). CATA Alliance literature suggests that employment of entry-level candidates in Canada is dependent upon first filling vacancies for senior level positions.

Supply of software labour

The adequacy of the system of software labour supply is difficult to assess when the magnitude and nature of software labour demand, aside from rough estimates, is unknown. Even if the nature of software labour demand were better known, the information required to assess supply channels is inadequate. New software workers can come from a wide range of possible areas, including the education and training system, the unemployed, other industries, or other countries. As well, levels of supply can be affected if software workers decide to leave the country or to switch to another occupation. The available information on supply channels and levels is imperfect if it exists at all. For instance, data on supply from the education and training system is available only for the public education system (see section IV), leaving out the likely significant numbers stemming from the private software training sector. In the realm of cross-country flows of software labour, the data do not permit a complete analysis. While we know that there is a net worldwide *inflow* of computer scientists/ mathematicians, and engineers through the permanent immigration system to Canada, it appears that there is likely a net *outflow* of workers under temporary NAFTA provisions to the United States, although data in this area are imperfect (Fellegi, 1997). We know very little about the kinds of workers that leave Canada and those which replace them, but it has been argued that if cross-border flows of labour are measured according to the dollar value placed on human capital gains and losses, Canada faces a net human capital deficit to the United States (DeVoretz, 1998).

In the final analysis, it is difficult to get the kind of demand and supply labour market data that provides a reasonable basis from which to assess a potential shortage situation. There are less direct indicators that might be used as proxies to signal a shortage situation, such as particularly high wages for software workers, or increased hours of work among the existing pool of software workers. A recent study by Gower (1998) of programmers and systems analysts shows that, on average, neither of these indicators emerge in the software labour market of 1997. Recall that the section on earnings showed wages to be average within the context of other scientific and technical work. Analysis of hours of work by Gower shows that on average, programmers and analysts working full-time work about a 40.0 hour workweek, slightly below the time worked by their peers in other scientific and technical occupations (41.1 hours). Further, the average hours worked by programmers and analysts had actually decreased slightly over the 1992 to 1997 period. However, these data represent aggregate data for the entire software sector. There still could be high wages or long hours being experienced by particular kinds of workers, with niche skills and experience.

To the extent that a shortage of software labour exists, imperfect information on the shortage makes it difficult to conclude what the causes of the shortage might be, and hence difficult for the sector to develop appropriate responses. A shortage created by insufficient interest in the sector among career seekers, or by inadequate training opportunities in the sector, or by a brain drain, require different kinds of interventions. The risk is misdirected responses, such as encouraging more students to enter private training programs, if this is not be the kind of labour that is in short supply.

Summary: work and people in software occupations

We do not know nearly as much as we would like to about the nature of occupations or the characteristics of workers in the software sector. The available evidence suggests that most software occupations promise a high rate of employment potential and growth (although so far overwhelmingly to men and not women), and that these jobs are typically filled by people between the ages of 25-44, who are paid relatively good salaries, at least in the Canadian context.

But there are several areas where the labour market information remains sparse.

There continues to be less than comprehensive information on income levels (including benefits and incentives) in the international context. Income levels are important from a human resources point of view because they affect the ability of the sector to attract top talent. In a sector which is dependent upon innovation and creativity for success, this is particularly important. Salaries appear to be strong in the software sector in the Canadian context. However, the high international demand for talented software workers ensures that highly experienced or specialized software workers have opportunities to work in one of several geographical locations. There has been particular concern expressed in the media and by some industry associations that highly experienced Canadian software workers are being lost to the United States because of better pay practices there combined with the favorable tax rate. If the loss of talented labour is revealed to be a problem for Canadian industry, a rethinking of current industry policy on attracting and retaining Canadian workers may be required. This is taken up again in Section IV.

The evidence also affirms the impression that there is a lot of labour turn-over in the software sector, in part brought about by the significant degree of self-employment and/or contract or project-based work. This labour market context presents challenges to the HRDP system. The existence of self-employment or contract work makes it more likely for employers to buy skills rather than risk losing a training investment. The many small firms in the sector would probably be even less likely to be able to weather a lost investment, and hence face greater incentives to buy skills rather than train for them. This situation makes it important that workers have sufficient learning opportunities to continue to ride the waves of change within the sector. It also makes it important that ways are found to keep educational and training curricula relevant, and also to make sure that the training grounds produce graduates who are adept at adapting to change.
The state of education and training for the sector and its ability to meet these challenges is considered in the next section.

One of the most fundamental problems currently facing the HR planning and development for the sector is the lack of detailed information on the occupations, skills, and education and training paths that are in demand by software employers.

The next section looks at what an HRDP system requires to meet the needs of HRDP in the software labour market, how this is currently being achieved, and where there are gaps.

IV. Human Resource Development in the Software Sector

The purpose of this section is to examine the way in which the system of human resources development and planning (HRDP) works in the software sector to facilitate the career management of workers and to meet the skill needs of employers. This theme stems from some of the HR issues raised in previous sections. Strong global growth in the software sector has created a competitive arena in which there has been a consistently growing demand for skilled human resources, a critical input to the sector. Yet, certain aspects of the software sector pose challenges to the effective functioning of the HRDP system: the demand for human resources is for a wide range of general and niche skill sets that are subject to rapid change; significant numbers of workers are self-employed or experience relatively short job tenure who may not have the support or information to ensure relevant career development; and the growth of the software industry globally forces firms to compete for top talent, yet most employers are competing from small firms and might face obstacles to implementing or supporting extensive HR practices. A current perceived shortage of workers to meet industry needs has highlighted these challenges, and has raised questions about the ability of the HRDP system to respond.

This section will consider, given available information, the way in which the different components of the human resources development and planning system function in the software sector. The components of the human resources development and planning (HRDP) system are divided into several sub-sections for the purposes of this analysis (i) the post-secondary education and training system[9], (ii) the HR practices of firms in training, recruiting and retaining software workers, and (iii) the system of continuous learning.

Figure 4.1 illustrates the way in which the component parts of the overall HRDP system fit together for this analysis, with the arrows indicating the interdependence of these components for the overall functioning of the system.

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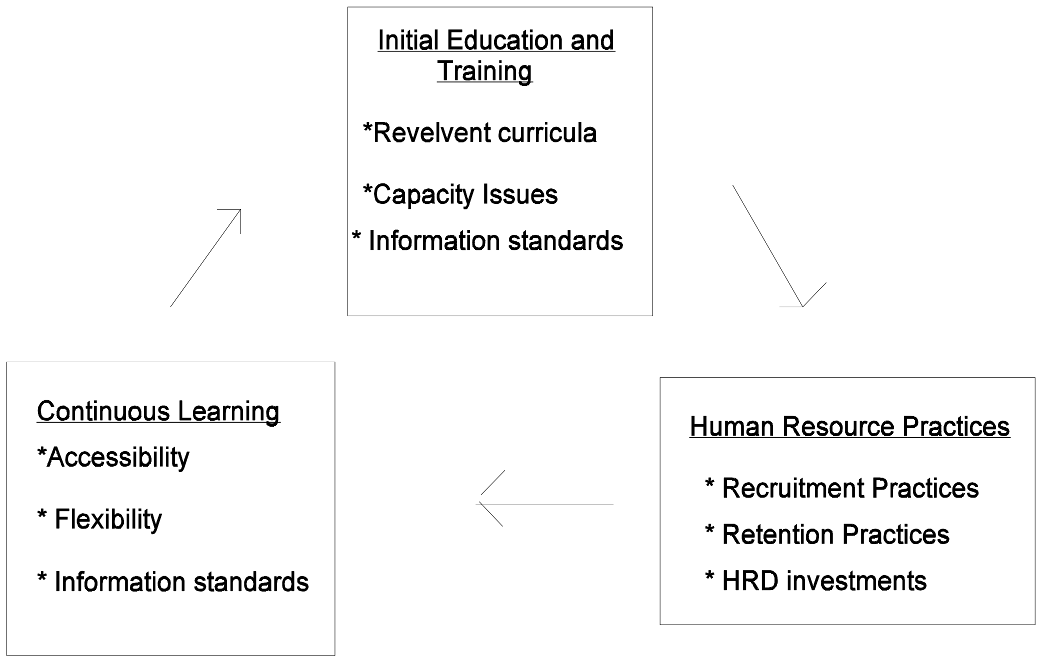
[9]Other levels of schooling play a less direct role in the development of human resources for the software sector, but are not a focus point of this paper.

Figure 4.1: Variables Essential to a Well Functioning Human Resource Development and Planning System in the Software Sector



More specifically, the functioning of the key components of the HRDP system serving the needs of the software sector can be thought about through the following set of questions:

- Are sufficient numbers of students attracted to train for careers in the sector?
- Do educational and training institutions have sufficient program capabilities to accommodate enrollment demand in relation to labour market demand?
- Do education and training programs provide students with the relevant knowledge, skills and experience to gain employment and to thereafter continue to build successful careers?
- Do workers have flexible, accessible opportunities for relevant, recognized forms of continuous learning?
- Do software graduates and workers find employment?
- Do employer human resources practices and government immigration regulations ensure

that there are sufficient quantities of skilled software labour in Canada to meet Canadian sector demand?

For the most part, our knowledge of the HRDP system in the software sector is insufficient to assess how well it is working on the basis of the aforementioned set of questions. But, the available evidence points to a few potential problem areas around information standards, training, and retention practices.

It should be noted that the assumption made in this section is that there is a set of software-related stakeholders that together have responsibility for making the HRDP system in the sector function well. These players include:

- Education and training providers, who have responsibility for a role in the initial and continuous learning of software workers;
- Employers, whose responsibilities lie in the areas of signaling the nature of labour demand to educators and workers, supporting the applied learning of the software workforce, and creating/maintaining an appealing image of the software profession. This work is often achieved through umbrella associations of employers, industry associations.
- Governments have a role to play in supporting those aspects of the HRDP system that do not work well when left to market forces alone. This includes roles in funding the education system, support to students, creating/supporting networks of stakeholders such as the SHRC, and engagement in production of labour market information that facilitates the functioning and monitoring of the HRDP system.
- Individuals, given the appropriate information and range of supports from the other stakeholders, have responsibility for managing their careers. This may be facilitated by collective association through a professional association.

What is interesting about the software sector is that the challenge of getting the HRDP system to function smoothly is increasingly being met by partnerships or alliances between these stakeholders. Alliances are often brought about by intermediaries such as the Software Human Resources Council (a body that is itself the result of cooperation between stakeholders), who broker between the players and bring stakeholders together to resolve common problems. Intermediaries such as this also exist at the regional level in areas where there are high-tech clusters, such as the Ottawa Centre for Research and Innovation (OCRI) and the Calgary Research Development Authority. Many aspects of the roles of these intermediaries in the software sector are new, so it will be interesting to see how they play out. The public policy role suggested by this kind of HRDP system is in the monitoring of these intermediaries (especially in the case that they are dominated by one stakeholder), through the provision of objective labour market data, research to identify gaps in the system (such as training loans for self-employed workers), and research to evaluate lobbying claims made by intermediaries (such as those around labour shortages).

The remainder of this section will focus on each of the key components of the HRDP system.

Education and training in the initial development of software workers

Interest in software careers: enrollment and graduates

Table 4.1A shows that average annual enrollment growth rates in software-related fields of study[10] at the post-secondary level exhibit strong recovery in the 1990s following a slow growth period in the mid and late 1980s. The numbers enrolled in 1996-97 were just beginning to surpass the enrollment levels that were reached at the peak of the growth period in software-related enrollment in the early 1980s.

University degree completion also rose in 1996 compared to1990 in computer science and electrical engineering. The growth rate has been particularly strong at the graduate level over the last decade. However, the numbers of students graduating at the undergraduate level in these fields in 1996 has yet to match its peak in 1986 (the peak was actually 1987 in the case of electrical engineering) (Table 4.1B).

The low software-related enrollment levels of the mid-to-late1980s led to a concern among industry stakeholders that the image of the software profession was unappealing to young people making career decisions. This led to initiatives by a range of stakeholders, often in partnership, to promote the idea of a career in the software sector among young people. Some programs are targeted at groups who are under-represented in educational and training programs for the sector, such as women and First Nations. A sample of these programs are shown in Box 4.1.

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[10] For simplicity, computer science and electrical engineering were selected for this analysis as fields of study that are "software-related," but software workers also come from other educational backgrounds (see discussion p.25-26 and Table 3.14).

Table 4.1A University and college full-time enrollment figures and growth rates, 1980-81to 1996-97

	1980-81	1984-85	agr* '80-'84	1985-86	1989-90	agr* '85-'89	1990-91	1996-97	agr* '90-'96
University									
Computer Science									
Undergrad	6116	12841	20.4	10970	8031	-7.5	8342	13405	4.9
Graduate	543	1009	16.8	1066	1342	5.9	1307	1589	-0.2
Electrical Eng.									
Undergrad	6324	8404	7.4	8421	7967	-1.4	8003	8458	0.2
Graduate	726	1354	16.9	1361	1756	6.6	1911	2056	-1.6
All Fields									
Undergrad	337952	406306	4.7	412421	453482	2.4	468296	498036	0
Graduate	44665	54886	5.3	54858	61545	2.9	63835	75599	0.8
College									
Computer science and math	8514	17876	20.4	15731	12000	-6.5	12079	194981	10.12
All fields	182372	225796	5.5	224175	213724	-1.2	220839	285245	5.32

Notes: ***** average annual growth rate.
[1] This figure is actually for 1995-96 because the later figure is not available.
[2] The calculations for these figures are for the 1990-91 to 1995-96 period for the reasons outlined in note 1.
Source: Association of Universities and Colleges of Canada and *Education in Canada*, Statistics Canada, 1997.

Table 4.1B University degrees, figures and annual average growth rate, 1984-1996

University Degrees	1984	1986	1990	1996	AGR %
Computer Science					
Undergrad	3134	3770	2752	3451	0.8
Graduate	256	329	419	547	6.5
Electrical Eng.					
Undergrad	1954	2240	1953	1995	0.2
Graduate	371	477	518	670	5
All Fields					
Undergrad	108925	119813	130629	150282	2.7
Graduate	18236	19808	22163	27834	3.6

Source: Association of Universities and Colleges of Canada.

Box 4.1 Initiatives to attract future workers to software careers

Shad Valley: This award-winning software educational program for high school youth involves more than 200 companies, eight host campuses and hundreds of high schools each year. Its objectives are to expand the career horizons of youth, foster entrepreneurial abilities, build bridges between industry and education, and contribute to sponsors' long-term recruitment efforts.

River Oaks Elementary School: The elementary school was established with the sponsorship of several government and almost a dozen corporate members including Apple Canada Inc.. As a result it is equipped with a networking system, notebook computers, and computerized learning activities in almost every realm of education. In the Scarborough School Board, Oakridge Junior Public School, Samuel Hern Senior Public School, and Heritage Park Elementary have added high tech components to their curricula, and receive some of the same corporate sponsorship (King, 1996, online).

SHRC Career Awareness Program: an initiative to achieve a presence in schools across Canada to address the image issues of the software industry and to promote the software industry as a viable and appealing career option. This initiative includes a national guidance counsellor steering committee (SHRC homepage, Swinwood).

Information Technology Management (ITM): a youth initiative by the SHRC in partnership with Knowledge Architecture Inc., developed to provide a classroom environment where students can develop information technology skills relevant to delivery of projects and services within their school and communities. The project includes an on-line learning resource where students can design projects and access mentors for assistance. It can be delivered as part of the school curriculum or as an after-school activity. It has already been implemented in some form in 20 secondary schools in BC and in 18 Ontario schools (SHRC homepage).

SchoolNet: a program to link Canada's 16,500 schools and 3,400 public libraries by 1998. Opportunities for youth to gain technology-based work experience in the multi-media industry has stemmed from this project (HRDC web page).

Cisco Networking Academy: Cisco is donating a curriculum to thirty high schools, colleges, and technical schools across five provinces to graduate about 1,200 students with skills in designing, maintaining, and building computer networks.

Michael Smith Awards for Science Promotion: a non-monetary reward that recognizes Canadian individuals and organizations who inspire a passion for science, technology, engineering and mathematics outside of the formal school system (HRDC web page)

Partners: jointly directed by the Ottawa Centre for Research and Innovation (OCRI) and the Ottawa-Carleton Learning Foundation, this program supports a number of initiatives with the aim of exciting young people in science and technology, such as *Destiny 2000*, an exposition for all grade seven students in the Ottawa-Carleton region (OCRI).

First Nations and Innuit Programs: science and technology summer camp and Internet link programs (HRDC web page).

National Science and Technology Week: an annual ten day celebration with 2,000 events across the country to promote awareness of the importance of science and technology and related career opportunities (HRDC web page)

Prime Minister's Awards for Teaching Excellence in Science, Technology and Mathematics: honours exemplary elementary and secondary school teachers across Canada who have had a proven impact on students interest and performance in science, technology and mathematics (HRDC web page).

Science Culture Canada: provides approximately $2 million per year largely to national or provincial/territorial non-profit groups that encourage youth to develop skills and pursue studies in science and technology (HRDC web page).

National Research Council programs: To assist the development of small and medium-sized enterprises (SMES) and provide valuable work experience to graduates, the National Research Council, through the support of the 260 Industrial Technology Advisors who form part of the NRC's Industrial Research Assistance Program, are providing collaborative research and technology internships from 1997-99, where almost 1000 unemployed or underemployed high technology workers will have the opportunity to work in collaborative research with the NRC.

The establishment of five women as new university chairs in science: selected by the Natural Sciences and Engineering Council and funded by the federal government with $1.25 million to be matched by private sector contributions from Alcan, Nortel, Petro-Canada and IBM, to provide role models to young women.

Capacity of universities

A recent report by Nortel points to the fact that a lack of interest by young people in the software sector is not currently the issue of greatest concern -- rather, the concern is that the capacity of universities is too limited to be able to accommodate the growing demand by youth to train for the sector. The report claimed that the Universities of Toronto and Waterloo received over 3,000 applications each for their engineering programs, while each university could accept only around 800 students. The report argues that these programs are not receiving sufficient funding to be able to accept the numbers of willing students that will be required to meet the skill needs of the high tech sector in Ontario (Hill, February 11, 1998). In response to this situation, the Ontario Government promised to match industry contributions to double the number of available spaces in engineering and computer science programs (Government of Ontario, 1998). The Ontario Government has also allowed universities to raise tuition for technology-related programs, as long as they set aside a portion of increased revenues for student-aid programs.

These measures are not however implemented in the absence of controversy, because increased expenditures on science and technology sometimes come at the expense of expenditures on the arts and humanities, and higher tuition fees threaten to hamper accessibility.

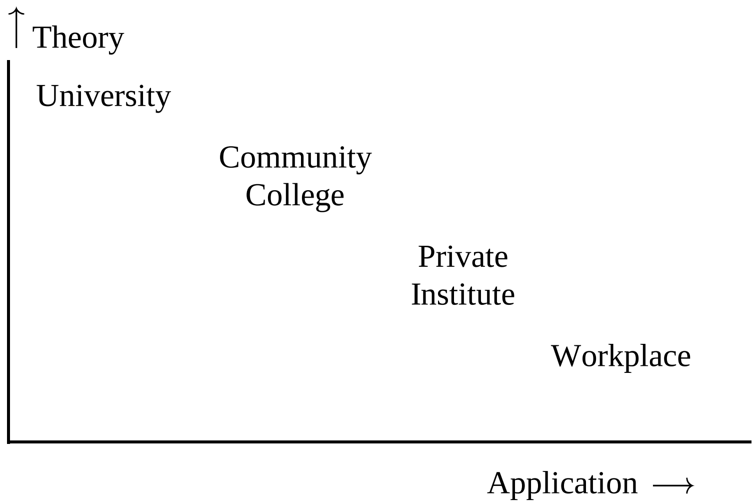
Another capacity-related issue is the recruitment and retention of professors/instructors. It has been reported that McGill University has actually had to cut its enrollment because of an inability to fill eight vacancies for professors (Bryan, April 29, 1998), the University of Ottawa has lost five professors over the past two years to schools in the United States or to the private sector (Chianello, 1998), and the Carleton University Chairman of computer engineering has complained of similar staffing problems (Hill, February 13, 1998).

The education and training received by students relative to industry skill needs[11]

University and non-university software education and training programs have traditionally used different approaches to training, and may have different target clients. The traditional roles of each of these institutions can be thought of as set out in Figure 4.2. Universities are traditionally known for providing students with a heavy emphasis on the theoretical underpinnings of software technology, while colleges and private training institutes provide a more applied focus.

[11] Qualitative information in this section is based on an investigation of education and training institutes in the Ottawa area. As such, the information may not be generalizeable across the country.

Figure 4.2: Approaches to training in the education and training market



The strong theoretical knowledge base that is taught at universities is a particular advantage in a sector where technology changes with rapidity, because this enables graduates to apply a common tool-box of problem-solving and other skills to various forms of technology throughout their careers. However the actual programming languages and software/hardware with which university students gain these skills can be less than current, so the applied skills that university students have upon graduation may not always be those desired by industry. This has renewed the debate over whether universities or employers ought to be providing workers with applied industry-relevant training. Some argue the importance of academic independence and of teaching basic conceptual skills that cut across technological innovations rather than catering to industrial technological "fads". This line of argument places responsibility for specific industry skills training on the employer. Employers have however been reluctant to wait to train students once they graduate, because of immediate skill needs (we look at training later in this section). The response has been increased industry-university partnerships, often facilitated by government support, through which industry provides resources and modern technology to universities in return for use of student talent towards industry-directed research priorities. This gives students industry-relevant skills and potential job contacts, as do the longer co-op placement opportunities that have been integrated into some university programs (Hill, February 11, 1998). A sample of these initiatives is listed in Box 4.2 .[12] Whether these new partnership initiatives will result in striking a more relevant balance between theory and industry skills remains to be seen.

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[12] It should be noted that links between industry and the educational system are not new. In 1990, the software sector study done for Employment and Immigration Canada attempted to quantify the degree of connections between industry and educational institutions. The telephone survey of 700 software and in-house firms revealed that 31 percent of firms hired students during co-op terms, 24 percent recruited workers from schools through a formalized hiring procedure, 22 percent advised schools on training needs, 22 percent worked with schools on training needs, 14 percent loaned or supplied equipment or software to schools, and 10 percent supported students through scholarship/bursaries (Employment and Immigration Canada, 1992).

Box 4.2: **Policies and initiatives to improve the university approach to educating and training software workers**

Government policy initiatives

- In Ontario, the May 6 1997 Budget included a new Research and Development Challenge Program, which encourages industry to get involved in the training of software students in the educational system. This programs offers to replenish some of the funding cuts to post-secondary education by offering $50 million annually for ten years to universities and colleges who find private sector partners for each of their high technology programs, and can put up a share of the research costs. Private sector participants get a 20 percent refundable tax credit in return. Ontario is also hoping to get funding towards this from the federal government, likely from the Canada Foundation for Innovation, introduced in the federal government's 1997 Budget.

Partnerships

- In the month of June, 1996, the *Consortium for Software Engineering Research* was announced to serve the purpose of pooling resources for research, training, and curricula coordination. It involves six universities from across the country and six members of industry, and is supported by $3 million in government funding through NSERC. Together the players plan to pool $18 million over five years to co-ordinate research through common themes and share knowledge (Chianello, 1996).

- A second consortium was also set up in June 1996 involving six universities in Ontario and two members of industry, who will collaborate on a part-time 2-3 year software graduate program.

- *Information Technology Professional (ITP):* This new program involves a $5.4 million investment by HRDC to be matched by $6.9 million from industry over three years and $3 million from education/training partners. Its aim is to train 1,300 post-secondary youth with skills for careers in the software industry through a full-time twelve month program involving an internship component. The Software Human Resources Council as well as some software companies award certification upon completion of the program. The program started in September 1996 (SHRC web page; HRDC news release, March 20, 1996).

- *Microelectronics Bridge Camp*: The Strategic Microelectronics Consortium involves the coordination of industry and universities to upgrade the skills of engineers and technicians to bring them up to speed on microelectronic design within two to four weeks. McGill University, Carleton University and the University of Toronto had sixty students enrolled in the summer of 1998. Companies involved include Focam Technologies and CAE Electronics (Bryan, June 24, 1998).

- *School of Information Technology Engineering* (SITE): Dr. Gilles Patry, Dean of Engineering at the University of Ottawa, reports that about one-half of the research being done in their Faculty of Engineering is supported by industry (Tabaret, summer 1996, 17). The University of Ottawa and Carleton University have been expanding and modifying their high-technology programs to better respond to the industry needs. The Ottawa University-based SITE links all high technology related graduate programs together under one administrative unit, most of which are linked with Carleton University. The program plans to have direct links with industry, including an Industrial Advisory Board, extended co-op programs that begin earlier in a student's studies and expand in duration to reach 8 and 12 months by their final year, and possibly to attract industry members directly to campus through a reverse sabbatical concept. The University of Ottawa hopes to graduate 1,400 students from this program in 1998 (Standen, 1998).

With the college and private training school (hereafter non-university) approach to training, it is possible that the opposite problem could result, in that graduates may have trouble adjusting to rapid technological change throughout their careers, because these programs do not tend to focus on the teaching of the theoretical foundations of software or hardware technology. Unlike the traditional university approach, colleges and private training schools tend to provide applied industry-relevant instruction because they can direct larger proportions of their funds towards current facilities (rather than research), and because they tend to have close links with industry, which allow them to respond to the changing demands of the software labour market[13]. There are no statistics that track the career success of non-university graduates over the long term, so it is not possible to know whether this may be a problem area. It may also be the case that non-university and university graduates are simply geared for different kinds of careers in the software sector, where graduates from colleges and private training schools are more likely to be employed in positions requiring less theory to adapt to change compared to university graduates.

Information standards

Another problem area in the HRDP system that falls under the rubric of relevant training has to do with the absence of information standards. There are numerous possible suppliers of initial education and training for a potential software worker, so it is important for a well-functioning HRDP system that individuals have the necessary information with which to make a decision about where to invest in their training. This requires knowledge of the skills most in demand by industry, the different education and training options for learning these skills, and the varying career outcomes that can be expected. In many industries, these are expressed by industry-wide occupational standards and training certification mechanisms, which are largely absent in the software sector. It is plausible that the need for this kind of information is becoming even more pressing, because of the widening range of largely unregulated private training institutes from which consumers can choose to train for a software career. Occupational and training standards allow consumers to select a known entity and allow employers to recognize the qualifications of candidates.

The challenge for having better occupational and training standards in the software sector is the fast pace of change. Information would require updating on a regular basis by industry representatives and software stakeholders. One effort to improve occupational and skill information is currently being tackled by a range of software stakeholders in cooperation: the Software Human Resource Council (SHRC), the Canadian Information Processing Society (CIPS), Human Resource Development Canada, industry representatives, and academics, in the development of a Software Occupational Skills Profile Project (Box 4.3). It will be important that mechanisms are developed to ensure that interested Canadians have the information they need to choose the kind of occupations and related training most likely to result in employment.

[13] For an overview of the typical characteristics of private schools, see Sweet 1997.

Box 4.3 : The development of occupational and skills standards for the software sector

The Software Human Resource Council (SHRC) and the Canadian Information Processing Society (CIPS) are collaborating with Human Resource Development Canada, industry representatives, and academics in the development of a Software Occupational Skills Profile Project. The profile will be based on an examination of existing models and certification mechanisms, including those in other countries, as well as through other research and consultation. The project team is expected to present a paper which defines the software sector in terms of its occupational and skill sets, present a Software Occupational Skills Model, make recommendations for how to maintain the model over time, make recommendation for improved classification of software occupations for the National Occupational Classification system, contribute to HRDC's Essential Skills Profiles by submitting the essential skills profiles of software workers, and recommend further needs in the area of skills profiles.

Continuous Learning

When software workers leave the initial education and training system and become members of the labour force, their learning needs do not end. While it is essential that the initial education and training system function well, it is not sufficient for the continued success of the software industry and its workers. This success will also depend upon the existence of a well-functioning system serving the continuous learning needs of software workers.

Employers represent one possible avenue of support to workers to engage in ongoing skills development. A concern around the functioning of the HRDP system in the software sector has been that employers have not been providing enough support to this continuous learning component (Adams, 1997). In the absence of employer support, software professionals must initiate their own learning (e.g. enrolling in courses, reading software journals), which requires having the requisite time, information and money. In this section, we take a look at the available evidence on training and continuous learning in the software sector.

The extent of training supported by employers in the sector is difficult to measure, because it has diverse dimensions including the kind of training provided, the duration of the training, the amount of budget allocated to training, and the numbers of people trained.

There has been no recent measurement of the extent of employer-supported training undertaken in the software sector,[14] although there have been attempts to quantify employer-supported training for the entire IT sector. A 1997 CATA Alliance and Angus Reid survey revealed that 59 per cent of companies surveyed had no program in place to train workers. A study by KPMG and CATA Alliance (1998) found that only 23 percent of high tech workers in Canada and the US who responded to an email survey in 1998 were satisfied with the training and development in their current job, and younger workers (age 29 or younger) were even less satisfied with the extent of training and development. However, an Industry Canada study (1998b) of Canadian IT firms revealed a much higher percentage of firms providing some form of formal training: 84 percent. Together, these studies no not provide very conclusive evidence on the status of training.

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[14] The last attempt of this kind was made in the software sector study, where the survey of software firms and in-house departments revealed that almost three quarters of employers in the software industry provided some kind of training (Employment and Immigration Canada, 1992).

The literature on workplace training would suggest that certain aspects of the software sector context might create barriers to employer-sponsored training. [15] For instance, the likelihood of a worker to be participating in employer-sponsored training decreases dramatically as the size of the firm decreases, and we can recall from the previous section that the majority of firms in the software industry have fewer than 10 employees, affecting about one third of employees. The self-employed add another proportion of small workplaces to the mix. As well, we can recall from previous sections that the software sector is generally a place where small firms are functioning in an internationally competitive industry with rapid change, which might make it more likely for employers to hire workers who already have most of the skills required to perform the necessary work.

On the other hand, the literature on training also generally shows that individuals with progressively higher levels of education and income (with the exception of the highest income bracket) are more likely to participate in employer-sponsored training than other workers (de Broucker, 1996), which would characterize many software workers. Indeed, workers employed in the well paying/high education occupation "natural sciences, engineers, and mathematics" (which would probably include most software workers), usually has one of the highest participation rates in training (de Broucker, 1996). The literature also shows that a high rate of technological change and operation in international markets, characteristics of the software sector, are characteristics most associated with training.

Anecdotal evidence suggests that a lot of the training that takes place within the software sector is informal and self-taught, both on and off the job. There has been no study of informal training in the Canadian software sector. New research coming out of the Ontario Institute for Studies in Education at the University of Toronto however suggests the importance of informal job-related learning generally (Livingstone, 1998). According to this research, about 70 percent of Canadians report that their most important job-related knowledge comes from other workers or learning on their own. Canadians spend, on average, about fifteen hours of informal learning per week. Almost two thirds of those surveyed who were in the labour force or expect to be soon were engaged in computer learning related to their job, and about one half were learning other new technologies.

Although the training trends in the software sector are not completely clear, the existing evidence suggests that there is some formal employer-supported training, some degree of learning that takes place on the job, and some learning that professionals pursue on their own to keep up with developments in their field. It might be the case that the degree of the latter two types of training significantly outweigh the former type. If this is the case, there may be implications for the way we understand work in the sector. For instance, the previous section indicated that software professionals tend to work an average 40 hour week. Are software professionals in actual fact

[15] This information is drawn mostly from Betcherman, Leckie and McMullen, 1997, which provides an overview of the existing literature on workplace training and also presents new evidence.

expected or obliged to spend many more hours working per week on self-directed professional development? How is this experienced by workers in the sector: is it recognized by employers? Is it recognized towards diplomas, degrees, or certification programs? Is it experienced differently for employees, who might receive employer guidance and support, compared to self-employed workers or job-seekers? Do software professionals, particularly those without direct attachment to an employer, have adequate information with which to select learning materials or courses? How do professionals finance their own learning? Particularly when student loans are not an option in most provinces if a course or program is under twelve weeks in duration. These are the kinds of questions about the human resources development system in the software sector that remain unanswered, yet might be at the centre of how this system actually works. And, the reported shortage situation is one sign that it is not necessarily working that well.

In sum, it is difficult to get an accurate or complete picture of the nature of training in the software sector. But, perhaps due to pressures resulting from the shortage of workers, a number of new continuous learning initiatives have emerged that are better tailored to suit the particularities of the software sector context. Presented in Box 4.4, these training initiatives have mostly been coordinated through the Software Human Resource Council with the help of funding from Human Resources Development Canada and the support/ participation of industry and the education/training sector. In some cases they combine the concepts of employer support with individual responsibility for learning, for instance by making training available on a computer terminal or LAN at a firm, where training can be completed by an individual in short convenient segments that are designed to result in minimal disruption to the schedule of the activities of the firm. The training programs sometimes come equipped with competency level identifiers for individuals, and a career agenda development component, whereby an individual can identify training needs required to meet particular career goals, and then register for the appropriate modules. The expense may involve the depletion of a firm's training "meter" as each module is completed.

The Software Human Resource Council projects a large increase in the proportion of software professionals who will benefit from continuous learning opportunities as a result of the programs they have initiated. Most of their programs are just ending their development and pilot stages, so it is too early to tell whether these new programs will be effective in better meeting the continuous learning needs of workers in the sector.

This multi-stakeholder approach to grappling with shortcomings in this area of the HRDP system is worth noting. The role of the SHRC as a "warehouse" for the development of these new training initiatives has the advantage of allowing a wide rage of firms and their employees to potentially benefit from the results. Small firms may benefit in particular, because of their relative lack of resources to develop training programs on their own.

Box 4.4: Training initiatives

Retrain: Retrain is just-in-time computer-based training that is delivered in short course modules that can be completed at the convenience of an employee at the firm. This program consists of twenty courses, developed by FirstClass Systems Corporation with the participation of the Software Human Resource Council and the British Columbia Software Training Alliance (BCSTA), a consortium of private industry, post-secondary and training institutions. Firms can purchase the computer program and designate a budget for its use which depletes as employees complete training modules (SHRC web page).

Mentys - *internet training*: Mentys was developed by the Software Human Resource Council in partnership with Global Knowledge Network Canada to provide just-in-time training over the Internet/Intranet as a cost-effective training option for employers and workers. The training includes a Competency Key, which allows an individual to assess their current capabilities and design an appropriate and convenient training schedule. The developers are seeking ways to certify users who have completed Mentys training (SHRC web page).

Education Program for Software Professionals (EPSP): Previously known as *WIST*, this program is an instructor-led continuing education initiative that can be completed part-time at flexible delivery times scheduled by a firm, through the University of Waterloo, or the North York School Board. Completion of any one of six courses results in a certificate accredited by the University of Waterloo and completion of all six results in a diploma. The University of Waterloo and the SHRC are hoping to turn this project into a distance education program available nationally over the internet or on CD ROM (SHRC web page).

Software Engineering Curriculum: These courses have been developed by The Software Productivity Centre in BC, as one of the SHRC Skills Gap programs. The curriculum was originally delivered locally at a university venue to the 130 companies that were the founding members of this initiative. It was assessed as successful after 1000 individuals passed through the curriculum, and the courses are now to be sold as site-licenses worldwide in several different mediums. They are targeted at software developers at different levels from programmers to senior managers, and at a fee of approximately $300 per day, they are normally employer-sponsored (SHRC web page).

NT-Global Learning Organization: This project, developed under the SHRC by SYSTEMCORP ALG Limited is being piloted with the cooperation of Northern Telecom. The Learning Organization is a methodology for organizational development, and at Northern Telecom it will be "facilitating a systematic skills development program of life-long learning." This project will produce a set of multimedia tools that diagnose, outline prescriptions and maintain tracking statistics. It is intended to provide Northern Telecom employees with ongoing opportunities for expanded technical skills and broadened knowledge of general management skills which should ultimately improve productivity. (SHRC web page)

O-Vitesse: First run in 1996, O-Vitesse was developed as an intensive sixteen-month work and study program to train software engineers for Mitel, involving the cooperation of the NRC, Mitel Corp., as well as both the Universities of Ottawa and Carleton. Northern Telecom Ltd., Newbridge Networks Corp., and ObjecTime Ltd., are among others that have since joined the program, which originally trained ten students and is expected to train between fifty and sixty students in 1997 (Ottawa Centre for Research and Innovation and National Research Council web pages).

Certificate in Software Technology: This new program at the University of Ottawa is a part-time program designed for people already employed in the industry.

There have also been some initiatives by sector stakeholders that might cater to the information and financial needs of unemployed or self-employed software workers. For instance, industry has taken some role in retraining unemployed software workers, through programs such as O-Vitesse (see Box 4.4), and some industry associations have begun to place "job boards" on their web sites, such as the CATA Alliance web site which invites workers to include their resumes in an international database of workers called *TechnoSkill*. However, we do not really know whether the learning needs of continuous learners are being sufficiently met by the current system.

Attraction and Retention Practices

Well-functioning training and learning markets are not the only requirements for a successful system of human resource development and planning. Particularly in light of a possible shortage of software workers, other human resource issues for the sector have included the ability of firms to attract and retain workers. Attraction and retention policies include things such as the image of the software industry and profession, and human resource practices such as pay, benefits, opportunities for career development and working conditions. However, there is little available evidence on these indicators within the software sector.

Stunted enrollment rates in the mid to late 1980 (recall Table 4.1A) raised concerns that the software industry did not have a good image or a high enough profile among students choosing careers (Employment and Immigration, 1992). Recall from Box 4.1 that several measures have been taken by various stakeholders associated with the sector to raise the profile of the industry among youth, with an extra effort focused on the demographic groups traditionally least likely to consider the profession. Enrollment growth in software related programs in the 1990s suggest that information signals of good career opportunities in the software sector are reaching potential candidates, although as was mentioned earlier, there may be outstanding capacity and curricula issues. Of course, one concern with the new initiatives to attract youth is that more students could be attracted to train for the sector than can ultimately be employed. Better labour market information around the skills in demand by employers will be important in ensuring that new students training for the sector are able to steer themselves in viable career directions.

Another issue around recruitment is that some employers report having trouble recruiting workers with the skills and experience they need. (Recall discussion around the labour shortage in section III). As is described in section III, the lack of labour market information on the sector has made it difficult to make sense of the nature of these recruitment difficulties.

There is similarly very little information available on practices of firms that might be associated with retention. An Industry Canada study reported that 44 percent of IT firms were having either a moderate or high degree of difficulty in retaining highly-skilled workers, their main difficulties being better salaries offered by other companies in the industry or raiding by other companies. (Industry Canada, 1998a)

There has been a lot of media attention focused on the brain drain, reflecting concern that retention practices are insufficient. A recent new initiative by the US to raise the cap on the allowable number of temporary foreign high technology workers into that country has likely heightened the concern that it will be easier for Canadian workers to go south, and harder for Canadians to compete for global software talent. However the actual incidence of brain drain is difficult to measure (recall Section III).

In response to concern around recruitment and retention, several initiatives have been implemented. CATA Alliance has counteracted with various measures under the rubric of "Operation Brain Gain", which has included the implementation of *TechnoSkills*. A study by CATA Alliance revealed that 25 per cent of Canadian high-tech companies have begun to use "virtual" development teams, that bring employees from geographically disparate areas together to work for a firm through the Internet (Roik, August 1997). The Software Human Resource Council, Human Resources Development Canada, Industry Canada and Citizenship and Immigration Canada cooperated to launch a pilot program to facilitate the process by which software employers recruit temporary foreign workers in particular occupations deemed to be in shortage situations.[16] Regional bodies, such as OCRI, and the Calgary Research and Development Authority, have struck various working committees to grapple with the issues of attracting software professionals to the Canadian labour market and retaining them. Ideas include stepping up domestic recruitment efforts through Canadian trade fairs (to counter the dominance of American fairs), developing and providing information to Canadian software workers on the real differences in pay practices in the larger context of other quality of life issues, and promoting the image of the Canadian industry as a place with challenging and fulfilling career opportunities for Canadians.

A study by KPMG and CATA Alliance (1998) investigated the factors that attract workers to accept a position with an employer. They found that career advancement opportunities, training and development, and effective management figured more prominently into a worker's decision to join an employer than did salary, and further found that Canadian IT workers were not currently satisfied with these factors. The factors cited by workers as important may signal that those employers who support their employees' experiences with the HRDP system stand to be more successful in attracting and perhaps retaining workers.

The HRDP System

In sum, the software HRDP system faces some challenges, mostly rooted in the fact that labour market information on the sector is not yet sophisticated enough to be able to signal labour market demand in terms of the types of occupations, skills and types of education and training required. This makes it difficult for young people to make appropriate career and training decisions, for workers to make continuous learning choices, and for educators to plan relevant curricula. Because the timely infusion of people with the right skills is such an important resource to the sector, failures within the HRDP system could pose a threat to industry success. An HRDP system that does not function smoothly also risks translating into troubled careers for workers

[16]This program is being closely evaluated because concern has been expressed that it will allow firms to shirk their responsibility to support the domestic HRDP system, while employers claim that it will result in improvements to this system by allowing for the recruitment of the skills necessary for the whole system to continue to function smoothly.

who have selected this high-tech path. It is likely for these reasons that a number of actors with a stake in the success of the sector have coordinated in the development of corrective measures to target various problem areas: to develop better information, improve education and training channels, and re-think attraction and retention practices. These players include education and training suppliers, industry and industry groups, professional associations, and government, as well as the SHRC, regional development bodies and other stakeholder associations which have emerged as important intermediaries in coordinating these players and bringing together their respective resources, with the support and monitoring of government. Many of the fruits of these new partnerships are in the early stages of implementation, and it is yet to be seen whether they will result in improvements to the HRDP system. It will be interesting to continue to observe and assess this model of HRDP as it evolves, and to draw lessons for application to other sectors.

Outstanding Research Needs

- The second section revealed the lack of consensus over the definition of the software sector and its occupations. Yet successful job-matching in our labour market system is dependent upon definitions of occupations and/or skill sets, industries and education and training programs, that are widely shared by all stakeholders such that they can be recognized by students, workers and employers. In a sector where knowledge workers are critical, the lack of definition of these workers and their work represents a serious impediment to a well functioning system of human resources development and planning.

- The labour market profile in the third section revealed that employment in the software sector has been skyrocketing, but that women are underrepresented in this sector. Although their representation in software-related education programs has increased, women remain a minority. Some policy measures have been taken, in the areas of career guidance and mentorship, intended to counter sexist stereotypes that might be discouraging young women from pursuing software-related careers. This is an area to be monitored. Further, research is required to understand the recruitment practices of firms as they affect women, the kinds of occupations that women have within the sector, and the experiences of women once they enter software occupations, including rates of attrition.

- In section three there was a brief examination of the reported shortage situation in the software sector, although it was revealed that the tools we currently have to assess this situation are limited. As these tools are perfected, it will be important to distinguish between the various causes of a shortage, and to pick the appropriate corrective measures that are targeted to respond to the most likely underlying cause.

- We know very little about the role of the education and training system in preparing students for careers in the software sector. In section three we saw that a number of different fields of study offer to prepare students for careers in the software sector, and in section four there was more discussion about the way in which the education and training sector feeds into the software sector. How do the resulting careers from different fields and levels of study differ? Do students with a more applied education from colleges and institutes have success equal to those with more theoretical training in finding work throughout their software careers? How many people pass through private training programs with hopes of finding software careers? Is this point of entry into the software sector meeting with success for workers and employers?

- There are some reasons, outlined in Section four, that we would expect there to be a lot of employer emphasis on training in the software sector. Well-honed software-related talent is, after all, a software employer's most critical input. However the evidence does not point to overwhelming support by software employers for training, at least not for formal training, which is the kind that our labour market system tends to recognize and reward. This raises at least two broad sets of questions: First, why is this? What is the relative significance of the reasons for employers not to train, such as the fast pace of change in the sector, the predominance of small firms, poaching, etc.? Are there other, less obvious reasons such as an industry culture that favours buying skills and individual responsibility for learning? Second, if formal, employer-sponsored training is not the norm, what is? Is informal and self-directed training the norm? If, so, what implications does this raise for professionals as they move through their careers in terms of getting recognition for the learning they do, making time to meet the professional development expectations of current or future potential employers, and financing their learning? How does this experience differ by type of professional, say a self-employed contract worker versus an employee? Is this system working to the benefit of workers and employers in the software sector? What changes are needed to make this system work better and what are the public policy implications?

- In examining the human resources planning and development system in the software sector, the roles of various stakeholders and their cooperation/partnership in various instances towards the improvement of the system have been highlighted. It will be interesting to continue to observe the merits of this model in helping the HRDP system work in a sector such as software.

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Appendix 1

Definitions of the Software Sector

Software Human Resources Council Definition (1995b)

The SHRC divides the software sector into an industry and in-house component. The industry is further sub-divided into three subsectors.

Product: those who develop software products for sale outside firms. Examples include: accounting and financial software, administration software, education, training, games software, institutional software, manufacturing software, marketing software, scientific and engineering software, systems and utilities, user tools and other computer software.

Embedded: those who embed software in products for sale outside the firm such as: calculators, electronic, programmable; commercial and industrial telecommunications equipment, not elsewhere specified; computer fuel deliver pump, computer systems, computer training equipment, electronic computers and parts, radar equipment/related devises, sonar/echo sounding/related devices, and telephone apparatus, computer systems, jet engine thrust, and computer systems, tank and artillery fire control..

Service: those who provide software-related services for use outside the firm such as: professional services, software maintenance, systems integration services.

In-house: those who work on information systems in industries outside of the software industry including: automotive, electrical products (excluding embedded), finance, including banking, insurance and investment; resources, including oil, gas and mining; and government.

Statistics Canada Definition (Statistics Canada, 1998, and additional information requested)

Firms surveyed as part of the Software Development and Computer Services Industry are those which are classified to the Computer and Related Services Industry (SIC 772) in the Standard Industrial Classification of 1980. This includes firms who provide as their principal activity: computer facilities on a rental, leasing or time-sharing basis or such activities as contract programming, software development, computer consulting, database services, or computer equipment maintenance and repair.   In the annual report on this industry prepared by Statistics Canada (1998), data are broken down into three sub-sectors:

Product development: includes: systems software, financial software (non-industry specific e.g. accounting), application tools, manufacturing software (e.g. CAD/CAM, MRP, MMS, etc.), scientific and engineering software (e.g. mathematical, simulation, GIS, seismic analysis, etc.), industry specific applications (e.g. banks, hotels, etc.).

Professional services: includes: corporate EDP consulting, systems and technical consulting, contract programming, custom software development, training and education, facilities management, other professional services.

Processing services: includes: network - electronic information, network - applications (e-mail), shared processing, data entry, other processing services.

Appendix 2

Software Occupations according to the Standard Occupational Classification System 1980*

Major Group 11 - Managerial, Administrative, and Related Occupations
Minor Group 113/114 **--** Other Managers and Administrators
Unit Group 1131 **--** *Management Occupations, Natural Sciences and Engineering*

Major Group 21 -- Occupations in Natural Sciences, Engineering and Mathematics
Minor Group 218 **--** Occupations in Mathematics, Statistics, Systems Analysts and Related Fields
Unit Group 2183 -- Systems Analysts, Computer Programmers, and Related Occupations

Minor Group 214/215 -- Architects, Engineers and Community Planners
Unit Group 2144 -- Electrical Engineers

Major Group 41-- Clerical and Related Occupations
Minor Group 414 **--** Office Machine and Electronic Data Processing Equipment Operators
Unit Group 4143 **--** *Electronic Data Processing Equipment Operators*

The SAME Software Occupations according to the Standard Occupational Classification System 1990

Broad Occupational Category A -- Management Occupations
Major Group A1 **--** Specialist managers
Minor Group A12.021 -- Managers in Engineering, Architecture, Science and Information Systems
Unit Level A122.0213-- *Information Systems and Data Processing Managers.*

Broad Occupational Category C -- Natural and Applied Sciences and Related Occupations
Major Group C0 **--** Professional Occupations in Natural and Applied Sciences
Minor Group C04.214 **--** Other Engineers
Unit Level C047.2147 **--** *Computer Engineers*

Minor Group C06.216 **--** Mathematicians, Systems Analysts and Computer Programmers
Unit Level C062.2162 -- *Computer Systems Analysts*
Unit Level C063.2163 **--** *Computer Programmers*

Broad Occupational Category B -- Business, Finance, and Administrative Occupations
Major Group B5 **--** Clerical Occupations
Minor Group B52.142 **--** Office Equipment Operators
Unit Level B521.1421 **--** *Computer Operator*

Notes: The improvements in the 1990 SOC include the ability to separate "software" managers from other scientific management positions, and to single out computer engineers from other engineers (rather than approximating from electrical engineers).

* It should be noted that there is currently no consensus over which occupations are software occupations, so I have selected the most likely candidates.

The *Software Industry* as typically considered within the Structure of the Standard Industrial Classification (SIC) 1980

Division M-- Business Service Industries
Major Group 77--Business Service Industries
Industry Group 772 -- Computer and Related Services
Industry Class 7721--Computer Services
Industry Class 7722-- Computer Equipment Maintenance and Repair

The SAME COMPONENTS of the *Software Industry* as considered within the Structure of NAICS* **

Sector 51-- Information and Cultural Industries

Subsector 511 -- Publishing Industries Services
Industry Group 5112 -- Software Publishers
Group 5114 -- Database and Directory Publishers

Subsector 514-- Information Services and Data Processing Services
Industry Group 5141 -- Information Services
Industry 51419 -- Other Information Services
National Industry 514191-- On-Line Information Services

Subsector 514 -- Information Services and Data Processing Services
Industry Group 5142 -- Data Processing Services

Sector 53 --Real Estate and Rental and Leasing

Subsector 532-- Rental and Leasing Services
Industry Group 5324-- Commercial and Industrial Machinery and Equipment Rental and Leasing
Industry 53242 -- Office Machinery and Equipment Rental and Leasing

Sector 54 -- Professional, Scientific, and Technical Services

Subsector 541-- Professional, Scientific and Technical Services
Industry Group -- Computer Systems Design and Related Services Industry

Sector 81 -- Other Services
Subsector 811 -- Repair and Maintenance
Industry Group 8112-- Electronic and Precision Equipment Repair and Maintenance
Industry 81121 -- Electronic and Precision Equipment Repair and Maintenance

Notes:
Within the SIC, most data are available at the level of Industry Group (772). This means that most data used to understand the software industry currently includes a small proportion of hardware related activity such as rental, leasing, and repairs. The NAICS structure will allow the software industry to be more genuinely considered in its own right, divided into many more components for a more precise sense of directions within the industry.

***** North American Industrial Classification System, Canadian Edition.
****** Source: Concordance table from SIC to NAICS provided on the Statistics Canada web site.

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