Factors Impacting the Supply and Demand of IT Workers in Canada and the USA

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Abstract

From its early post-Second World War beginnings, IT employment has risen steadily, with over 3% of North American workers now holding IT occupations and perhaps another 10% working in IT related or IT-enabled fields. Since the mid-1980s, there have been reports of shortages -- both of IT workers and of specific IT skills. This long growth period was dramatically affected during the "recession" that took place at the beginning of the 21st century, when the IT industry and IT jobs were more significantly affected than other areas of the economy. Today, we find contradictory reports of continued unemployment and slower growth, along with the resurgence of predictions of labour and skills shortages. To some degree it seems to have been a "jobless" recovery. Enrolment in university computer science and IT programs is down dramatically, offshoring of IT work in on the increase, and questions are being raised about the role of immigration, despite government predictions for growth in most IT work!

This paper is an attempt to build a comprehensive picture of the supply/demand situation in North America, drawing from both the Canadian and the US experience. Preliminary conclusions suggest that the growth of IT work will continue but in a different pattern than in the past and that current responses are inadequate to meet the current challenges. Without action by industry, academe and industry, many current problems will continue and could have an adverse effect on both the Canadian and US economies and on the employment prospects of IT workers (especially new entrants and older workers).

Key Words: IT workers, labor analysis, shortage, skills

1. TRENDS IN IT EMPLOYMENT -- WHY IS *IT* OUT OF FASHION?

The growth of IT work in North America has been dramatic. In 1961, less than 0.02% of workers in Canada worked in IT-related jobs. By 2001 this had grown to about 3.3% of all jobs (Gagnon, et al, 2003). No other area of employment in North America has seen this level of change. The work is "white collar", seen as professional in nature and is relatively highly paid. Most workers are college or university educated. Unemployment has generally been low. For most of this period, it has been an occupation in high demand from young people. Yet this is no longer the case! High school and university students no longer seem to see it as a desirable occu-

pation and questions are being raised as to longer-term prospects in the field.

This paper looks at the supply and demand of IT workers in North America. The field is complex and it is difficult to build a comprehensive picture. However, by drawing from a range of studies in Canada and the USA such a picture can be built. Where possible the paper compares and contrasts the experience in the two countries, otherwise it presents the best information available from either country.

The paper also examines the changes in the labour market since the emergence of IT work as a significant economic activity up to the present day. It then looks at some projections for the next 10 years or so. Next, it examines significant issues related to the supply and demand of workers, including enrolment trends in IT related college and university programs and the skills required to do IT work. Specific issues such as: offshoring of IT work; immigration policies and their impact; young people's attitudes; the under-representation of women; and possible ageism in the IT industry are also discussed. Finally some tentative conclusions are drawn and suggestions made for action.

For its Canadian data, it makes extensive use of the work of the Software Human Resources Council (SHRC), a not-for-profit sector council jointly funded by the Federal government and industry, as well as material from Statistics Canada and The Information Technology Association of Canada. For the USA, major sources of data include the Bureau of Labor, the Department of Commerce and the Information Technology Association of America. No original data collection has been done for this paper, which relies on the data available from other studies along with some simple inquiries to databases available from government sources. Given the wide disparities in methods of classification and reporting across these sources (as will be discussed later), data from different sources are sometimes combined to create a complete picture, despite, in some cases, quite different derivations.

The Canadian government has sponsored IT labour market research for the last 25 years or so. The first national study (Peat Marwick Stevenson & Kellogg, 1992), using data up to 1991, found that "software workers" were in high demand; projected double digit growth rates for the coming decade; indicated both a shortage in the supply of workers and a growing skills gap. It also identified the challenges caused by a reduced enrolment in related educational programs; an above average participation of immigrant workers; a reduction in female participation; and a poor image of the work amongst young people, despite strong employment and salary statistics. This study led to the establishment of the SHRC.

As a general comment, the USA has a fuller range of data and studies on overall supply and demand issues, while Canadian work focuses on more specific aspects of the workforce, such as skills and detailed demographics.

2. THE EVOLUTION OF IT WORK

Perhaps a good place to start is with definitions of IT work. The IT world is not a favourite with labour statisticians. The field has only been around in significant numbers for some 30 years and job titles and job content change frequently, thus longitudinal studies are difficult to manage.

IT Job Classification in Canada

Canada started tracking IT workers in 1961, when the (then) Department of Labour first included the occupation of "Computer Programmer" in the analysis of the 1961 Census. By 1971 the (by then) Department of Manpower & Immigration, still included only one job code for the IT sector, the description now being "Systems Analysts, Computer Programmers & Related Occupations." No significant changes were made until 1992, with the introduction of The National Occupation Classification (NOC) by the (yet again renamed) Employment & Immigration Canada, which included 6 IT occupations. Most recently, in 2001, Statistics Canada and Human Resources Development Canada (HRDC) agreed on a (for practical purposes) identical classification system, with 12 codes. In parallel, and for slightly different purposes, the Software Human Resources Council (SHRC) has developed an Occupational Skill Profile Model (the OSPM), with 21

job classifications in five groups, and was used as a source for the HRDC model. The evolution of IT job classification in Canada is shown in Exhibit 1.

IT Job Classification in the USA

Similar challenges in classification exist with the US data. The Bureau of Labor Statistics (BLS) provides a wide range of survey data, across some 14 IT-related classifications, which are also often used by the Office of Technology Policy (OTP) in the Department of Commerce. A trade group, the Information Technology Association of America (ITAA) also conducts surveys and other research on the US IT labor market. The classification schemes used by each of these are compared in Exhibit 2. (Much of the literature on the IT labour force comments on the difficulty of longitudinal analysis due to the problems of classification and differences between the various sources.) As a result, there is frequent reference in US studies to the "core IT occupations" -- usually taken to mean Computer Engineers, Systems Analysts, Computer Programmers, Data Base Administrators and Computer Scientists/Computer Support Specialists. This is then used as a surrogate for the wider IT workforce.

Some engineering disciplines have ben included in IT labour analysis since the early 1990s, ad likely because of their link to external professional accreditation, have not seen much change in job titles, except in the area of software engineering.

From this review, it can be seen that, while new IT jobs emerge the "traditional" jobs of analyst, programmer and support still exist and dominate, but are now subdivided into quite a number of more specific roles.

3. THE SIZE OF THE IT WORKFORCE IN NORTH AMERICA

Numbers of IT Workers in Canada and Growth Rates

Exhibit 3 shows the growth in IT-related work in Canada from 1961 to 2005. This shows steady growth from 1960 to about 1980, followed by almost continuous high growth from 1980 to 2002, peaking at about 625,000, and then hitting what amounts to a plateau at around the 600,000 level over the last 4 years. Looking at the data from 1991 to the present, the growth in IT employment from 1991 to 2001 was at a rate of about 12% per year, compared to an overall growth in the Canadian workforce of around 1.3% per year throughout that period. (Data drawn from Gagnon et al, 2003 and Industry Canada, 2005)

The 2000-2005 analysis also provides data on unemployment rates in IT jobs. IT unemployment peaked in mid-2002 at about 6% and has declined steadily since then to 1.9%. (By comparison, overall unemployment in Canada was almost 8% in mid 2002 and about 7.6% at the end of 2005.)

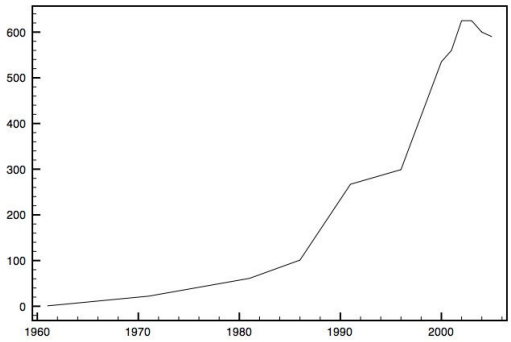

Exhibit 3: The Canadian IT Workforce, 1961-2005 (`000s)

Using their IT employment taxonomy of 21 occupations, an SHRC study (Wolfson, 2006) found that, in the private sector, six of these occupations made up almost 2/3 of the workforce:

- Computer Programmer (18.0%)
- Business Analyst/Consultant (12.4%)
- Software Engineer (9.9%)
- User Support Technician (8%)
- Computer/IS Manager (7.8%)
- IT Project Manager (7%)

There are some variations in the public sector, but the same concentrations generally hold true. Employment and Immigration Canada rates all of these occupations to have "good" (the highest rating) prospects

for careers, except programmer -- which is rated as "fair".

Numbers of IT Workers in the USA and Growth Rates

The growth of core IT workers (in this case Computer Systems Analysts and Scientists and Computer Programmers) was reported in a study by the OTP (Meares & Sargent, 1999). A chart from that study is reproduced as Exhibit 4 and shows a growth from some 719,000 core IT workers in 1983 to 2,084,000 in 1998. This report then projected further growth to 2006 with annual growth rates exceeding 10% in every occupation except programming. This is one of the few studies to mention that demand could be higher than simple growth because of the exit of some workers from the occupation. (They project an annual "replacement" rate of around 1% for most jobs except that of programmer, where they see a much higher rate of about 5% per year.)

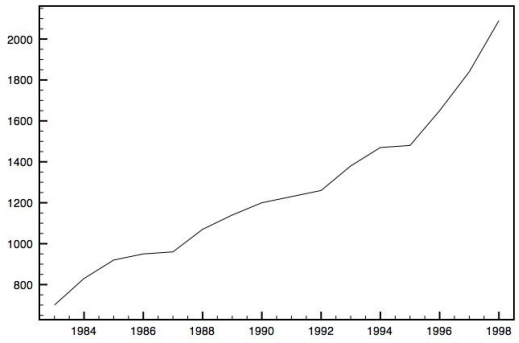

Exhibit 4: The US "Core" IT Workforce, 1983-1998 (`000s)

More recent data drawn from the BLS database show a current IT work force of some 3.8 million, across some 14 occupations, and projects annual growth rates of around 2.4% to take the workforce to about 4.9 million by 2014, an increase of just over 1 million, or about 90,000 net new jobs per year. If we assume about 1% attrition, this would mean about 130,000 new vacancies per year. Exhibit 5 shows the occupations, the current workforce and the estimated changes. It should be noted that six of these categories are rated by BLS as growing "much faster" than the workforce as a whole and another four as growing "faster". Only four are seen as growing at the same or lower rates. In most IT occupations the growth rate is projected to be double or triple the overall average. The BLS classification is somewhat more restrictive than the Canadian and, using the Canadian framework, the number of US jobs would likely be higher.

It should also be noted that the ITAA, using some quite different characteristics in a survey they have repeated several times in recent years, estimated the IT workforce in 2004 to have been 10.5 million (up just over 200,000 from 2003), projecting further growth of some 230,000 to 2005 (ITAA, 2004). However, these numbers have been subjected to significant criticism based on both the sampling method and problems with earlier estimates (Hayes, 2004). In particular there has been criticism of the use of "normal" job vacancies -- every industry has a proportion of vacancies that exist as part of the normal moves of people within the industry -- as a predictor of job shortages (Stager, 2001). Also the classification system used by ITAA does not recognize either management roles or the business systems analyst roles, instead embedding such work as a subset of the other categories, a somewhat questionable practice, at least for the projection of supply and demand.

In summary, the strong growth in employment in the IT field has plateaued, but will likely begin to pick up somewhat. However, it seems clear that, while better than average job prospects still exist, they are unlikely to return to the levels experienced in the 1990s.

Differentiating Between the ICT Industry and the IT Workforce.

Another factor that adds confusion to the conflicting reports on the growth/decline of the IT field is determining whether the reference is to the workforce of individuals who work in IT occupations (e.g. analysts, programmers, computer scientists, etc) or to the various firms that offer products and services in Information and Communications technology. We are dealing with both a functional discipline and an industry. As a result, while the ICT industry employs many IT workers, it also employs a wide range of individuals whose jobs do not appear in IT job classifications (ranging from salespeople to clerks to production line workers). In addition, the Industry itself has quite different components experiencing quite different

market conditions (e.g. reductions in manufacturing, growth in services).

4. FORMAL EDUCATION & TRAINING

University & College

In both Canada and the USA the higher education system provides IT-focused graduates with degrees in such subjects as Computer Engineering (CE), Computer Science (CS), Software Engineering (SE), Computer Information Science (CIS), Information Systems (IS), Management Information Systems (MIS) and Information Science (Freeman & Aspray, 1999). There has been limited examination of the enrolment in such programs, with such work that has been done focusing mainly on Computer Science and, sometimes, Engineering (this narrow definition of IT-related degrees is a common refrain in the literature and in government/industry studies, even though only about a third of the workforce claims to have this background). (Gunderson et al, 2005)

Gunderson et al (2005) also report that almost 80% of Canadian IT workers have university degree or college diplomas, with about 50% having either bachelors or higher degrees. Those holding degrees (in the private sector) had quite diverse fields of study (multiple degrees possible):

- 31.8% Computer Science & Software Engineering
- 23.5% Arts, Humanities and Social Science
- 25.6% Engineering (Electrical/Electronic/Computer/Systems)
- 12.5% Business
- 12.1% Math and Pure/Applied Science
- 17.3% Other

Thus, of the total IT workforce, less than 30% have directly related computer science or software engineering degrees. Those taking college programs are somewhat more likely to have taken computer science or software engineering (42.7%), making up another 14% or so of the total workforce. So, in total, less than 50% of the Canadian IT workforce has a directly related technical education. It was also reported that degree holders were less likely (only about 84%) to be Canadian citizens. Only about 20% of the degree holders took part in co-op programs. This study also reported that about 43% of the Canadian IT workforce came into IT from non-IT jobs.

In te USA, according to the OTP (Meares & Sergeant, 1999), about 2/3 of the IT workforce has a bachelors degree or higher, with a breakdown of:

- 46% IT & Computer Engineering (Includes IS/IT and CE)
- 26% Math & Science
- 14% Other Engineering
- 6% Business
- 8% Other

It is difficult to comment on the significant differences between these two surveys since the methodologies were quite different.

IT Degree Enrolment in Canada

One recent study (Vegso, 2006) reports that, in Canada, enrolment in CIS degrees grew from some 13,000 in 1992/93 to a peak of about 27,500 in 2001/02 and declined by about 2,200 or about 13% through 2003/4. Degrees awarded reached about 6,000 in 2003/4, will likely peak at about 6,500 in 2006/7 and then will decline somewhat based on the reduced enrolment in 2002/3 on (perhaps to a level closer to 5,000 per year). It should be noted that enrolment in CIS masters (9% growth in 02/03) and doctoral degrees (20% in 02/03) grew during this period, with a significant spurt in 2001/2 and on.

The SHRC (Michael Campbell Robinson Inc., 2005) recently surveyed Canadian University Engineering enrolment (including Computer Science, Computer Engineering and Software Engineering) and confirmed the above findings in regard to the three types of IT programs surveyed and reported a further decline in enrolment of some 8.5% from 03/04 to 04/05, and projected further declines in future enrolment. This contrasts to a growth of around 4% in "other" engineering programs. In more detail, it found a decline in Computer Science, Computer Engineering (and Electrical Engineering) but a significant growth in Software Engineering (28%) as well as growth in graduate programs.

Similar declines appear to have occurred in business/IT schools. While national data are not available, one school (with the largest Canadian undergraduate business program with an IT-focus) has experienced a decline in first year enrolment of some 36%, from 02/03 to 05/06 -- an average annual decline of about 12%.

IT Degree Enrolment in the USA

In the USA, the 2004/5 Taulbee Survey (Zweben, 2006) reported in its 35th annual survey of PhD granting schools of CS and CE that graduations and enrolment in CS and CE programs continues to drop from their peak in 2002/3. In the schools surveyed, the number of undergraduate majors has declined in each of the last 3 years (by 23% in 03/04, by 10% in 04/05 and by 21% in 05/06). It also noted that while PhD production continues to grow (15% in 04/05), masters degree production after peaking in 04/05 also fell off by 6% in 04/05. A significant proportion of masters and doctoral degrees are actually awarded to foreign students, many of whom will likely leave the country after graduation, although there are options for these graduates to stay in the country, often through H-1B visas. Taulbee data suggest that PhD granting CS schools in the USA will likely produce about 13,000 bachelors graduates in 2006, this the total for all schools is likely to be around 20,000. In addition, Keares & Sergeant (199) suggests that the college system produces around 9,000 graduates with associate degrees.

In the USA, Vegso (2005) found interest in Computer Science amongst freshmen, has had two significant peaks --in the early 1980s and in the late 90s, then fell dramatically in the last 5 years (from almost 4% of all stated majors to about 1.5%).

Fluctuations of enrolment in computer science programs have been in evidence for the last 15 years or more. The fall off in recent enrolment is significant and most likely not justified in term of job prospects. Of more significance however, is the over-focus on computer science and software engineering as the "natural" source of IT worker, since less than a third of the workforce have such degrees.

In-Career Training & Skills Development

IT workers gain the needed skills through training, formal and informal, as well as from education and professional certifications.

Industry studies generally show IT workers receiving more training than the workforce at large. For example, in Canada in 2004, almost half of the IT workforce received some formal training and over 70% received informal training, most commonly in the latter case through self study across a wide range of topics, with application software and systems software being the most reported areas. Most report that this is a "top-up" to refresh skills and not intended to fill education gaps from earlier education and skills. In about 90% of cases, the employers paid for the training (Gunderson et al, 2005).

In the same study, IT workers reported that a wide range of general skills was needed in their work, with interpersonal, analytic, communications and design skills dominating. However, they felt training was most needed in programming, project and people management, planning and systems administration and operation. Employers report that about 1/3 of new hires need to upgrade skills (about 1/2 for those recruited from abroad), requiring on average about 14 days of training. On a more technical dimension, a survey of most required IT skills (IDC Canada, 2005) reported the greatest need was for networking and Microsoft skills, and found a general move towards standards-based solutions and a skills rationalization, narrowing the focus to fewer technologies. In contrast, an examination of job advertisements from 2002 to 2005 (Prabhakar et al, 2005) show a strong focus on current web development skills and other programming languages. This focus on very detailed and specific skills and experience has been the subject of much criticism, and it has been suggested that these have become a significant barrier to job seekers with HR departments and IT recruitment firms using unnecessarily restrictive combinations of skills and experience and then, by the use of automated screening tools ignoring candidates who might be quite capable of doing the needed work, possibly with some additional training. (Matloff, 2002)

The ITAA reported (2004) that "the most important preparation for job obtainment"

was the combination of related experience with a four-year college degree in a related field. They found that, after hiring, job advancement was closely linked to on the job technical training and certification and that "softer" skills, such as interpersonal and communications skills, project management and analytic skills were also key to success. This is something of a paradox. When questioned IT executive suggest that the key skills need in the future are business-oriented, yet their recruitment behaviour continues to emphasize technical skills oriented (Bullen , 2006). This behaviour is also evident even in the case of new college graduates, with employers expecting them to have experience, not just education, in the needed skills (US Department of Commerce, 2003).

The studies done in this area, seem to indicate that, while employers emphasize the need for a related degree, and its broad ranging focus, often they are looking for some very current, very specific technical skills and this very tight specification has had an impact on the claimed level of shortages in the field. It seems also quite clear that education in the skill is not sufficient qualification and that actual experience is seen as the key factor.

5. OTHER ISSUES IN IT WORKFORCE ANALYSIS

Reliance on Immigrant Workers

Both Canada and the USA have a long history of growth through immigration, however there are significant differences in current practice, both in general and in the IT field.

The major differences relate to the balance between permanent immigrant and temporary visa workers. Both countries have established special temporary worker admission programs to meet perceived shortages in the labour force, however these differ considerably in their approach and scale. In Canada, there is a fairly focussed and small scale program -- the Information Technology Workers Program, which brings in about 1,000 IT workers per year in seven specific IT job types. In the USA, there is a more general program, the H-1B Non-Immigrant Visa, which covers a range of skilled occupations seen as in short supply, in which IT workers have generally made up the highest proportion each year, varying from about 30 to 70%. The H1-B visas are for a 3-year period and can be renewed for a further three years. This program brings in some 50-65,000 IT workers per year and these may now number some 300,000 workers -- some 8% of the core IT workforce in the USA.

In contrast to the Information Technology Workers Program, the H-1B program has been a subject of intense political debate, with two distinct camps. The IT industry promotes it as a very necessary activity to meet major worker and skill shortages without which they face very difficult problems (for example, ITAA, 2006). Opponents, including workers' associations and even participants in the program, argue that the numbers awarded are too high, that its primary purpose is to lower labour costs (with workers who are little more than indentured servants) and that it has had a significant impact on unemployment in the field, especially with new entrants and older workers. This point of view is well articulated by Matloff (2002) who has been a strong opponent of such schemes, criticizing them for ignoring well qualified US professionals and promoting agism in the Industry.

As a result of these policies, it appears that, in both countries, these new workers make up an above average proportion of the IT workforce. In Canada the majority of these workers are permanent immigrants and part of the much larger immigration program. In the US such workers are more likely to be temporary workers, raising questions of both the treatment of these workers and the possible dampening effect on employment opportunities for permanent residents.

The Impact of Offshoring

While outsourcing (the use of external firms to provide ongoing IT services to replace in-house IT functions) has been part of the IT landscape for over 30 years, the specific case of providing such services across national boundaries has only recently become a significant part of the IT landscape. The primary reason cited for outsourcing is cost reduction (likely to be of the order of 20%) but lack of availability of skilled workers is also mentioned. (Prism, 2004)

There are two major categories of offshoring related to IT -- services directly related to IT work and IT-enabled services (ITES), the latter often business process focused, such s call centres, and making up about ¾ of the total business. India holds about 80% (about $10 billion in 2002/3) of the total market.

While offshoring receives a great deal of public comment for its impact on employment the short and long-term impacts are somewhat difficult to determine. Although large numbers have been projected by many analysts, it has been difficult to show direct correlation between offshoring and IT job loss. Further such projections seem to be strongly focused on the demand side and may ignore possible limits to growth emerging in the key suppliers. India, the major supplier, is projecting major shortfalls in producing enough workers (as much as 50% by 2010). Further, this shortage is likely to increase labour costs and, ironically, Indian studies discuss the need to outsource their work to new markets such as China, where it is less clear that a suitable environment and infrastructure exist (NASSCOM, 2006).

It seems obvious that offshoring has had an impact on less skilled jobs and may have a dampening effect on the growing demand of higher level jobs, however the long term impact on these jobs in either country is far from clear. Canada is actually a provider of offshoring services to the USA and the USA has a strong positive balance of trade in professional services, providing some support to claims that offshoring may have a positive impact on their respective economies.

Although strong arguments can be made that offshoring can improve the overall competitiveness of the US and Canadian economies and even their IT industries, it does has a dampening effect on IT worker demand. Further, the movement offshore of lower level skilled work will likely impact the availability of junior and entry level jobs in the field.

Image and Attractiveness to Young People

An article in the British newspaper The Guardian (Swain, 2003) sums up the popular view of the problem quite well.

> *"Why do so few women enter the profession. Are they really discouraged by the stereotyping of the IT workforce as anoraks? The answer is yes. Women perceive jobs in IT as excessively complicated and not dynamic. If you ask a woman to characterize a typical IT professional, she is likely to describe a young man with excess facial hair, sitting behind a computer all day munching pizza and guzzling coke."*

(Note: The word "anorak", as well as describing a hooded waterproof coat, is also used in the UK to describe someone, normally male, with an enthusiasm bordering on obsession with a particular hobby or interest and closely aligns with the North American term "nerd" or perhaps even more to "geek." -- further note: some suggest "a nerd is a geek with some social skills!")

The specific issues of female participation are discussed in the next section, but the quote encapsulates one of the challenges in attracting young people into IT. The same article goes on to say, "This view is far from accurate." But, as any Marketing 101 student will tell us, "Perception is often reality."

The Peat Marwick Stevenson and Kellogg study (1992) of software workers in Canada identified a lack of any clear identity or definition of computer work. It suggested that the early "glamour" of computer work had faded and noted that, along with other scientific and technical disciplines, it was less popular amongst the young. Disciplines with a clear identity (often re-enforced through the TV and film industries) such as medicine and law are more visible and attractive. It also reports poor understanding in high schools relating to IT work in both course content and career guidance. More recently, Kamal (2005) found that high school seniors and college freshmen do not view computer disciplines as a rewarding profession" and that "Such perceptions are mostly based on a lack of information."

For most of its short history, work in IT has had two prevailing images, one being a discipline requiring good education, much in demand and often above average compensation, and the other being a rather nerdy job, requiring lots of math skills and solitary work in form of a computer screen. This has certainly had an impact on the level of interest in, and types of entrant to, the field. Now that the first of these images is under

attack, this has some serious implications. Further, it seems that most high school students have no clear idea of the nature of IT work and are thus less likely to choose it as a career.

Lower Rate of Female Participation

From the early beginnings, there have been concerns about the rate of female participation in the IT field. From 1981 to 2004, the rate of female participation in the Canadian workforce as a whole has grown from 40.6% to 46.7%. During the same period, the female participation in IT work grew from 28.5% in 1981, peaked at 30.8% in 1986 and, since then, has declined slowly to 25% in 2004 (Gagnon et al, 2003).

Much has been written on this issue and there have been a number of initiatives in both Canada and the USA to try to reverse this trend. While they may have had local impact, they have clearly not resolved the problem to any substantial degree.

Randall et al (2002) reported that "in a study of high school students, females reported computing as boring, involving logic or math skills and little contact with other people." It suggests that females were more interested in work that is people-oriented and requires communication skills.

The University of Waterloo, (highly respected for its programs in engineering and computer science) which had been experiencing significant reductions in female participation in computer science, launched a pilot project focusing on 14-16 old girls with little or no exposure to computing. It found that: "we know that an audience of interested females is available. We simply need to provide more opportunities" and that "there are strong indications that we have changed the image of CS for these girls." (Graham & Latulipe, 2003)

A study in a US institution (Kahle & Schmidt, 2004) suggests that "most women know very little about computer science prior to working or taking classes in the computer science field. It seems that not being informed is the most important reason why women are not enrolling." It further suggests that women are not encouraged by others to pursue careers in computer science, both at high school and at university.

In an alternate view, Short et al (2002) comment that "Most of the work to date, even by feminists, has accepted the prevailing idea that 'information technology' is virtually synonymous with engineering and computer science even though there is compelling evidence that IT is much broader and requires a wide range of skills." They suggest that the majority of IT workers do not have CS degrees and that the real emphasis should not be on getting more women into CS, but rather to make it clear that many jobs in IT do not need CS degrees and work to encourage women to pursue these jobs through a much broader range of educational activities. In this regard they also identify the significance of the "math barrier". Mathematics is used as a major screen to those entering the IT field, yet except for a few jobs, math is seldom used by IT (or any other) business professionals. Yet it is seen as the single most important school subject for entry into IT programs, perhaps as a surrogate for the applicant's ability to do abstract thinking, even though there is very little evidence that this is a valid association. This can be seen as a systemic barrier for the entry of young women, given their well-documented lower participation and interest in math in high school.

While the engineering profession has made efforts to increase female participation (with some limited success), the IT field has largely ignored this problem. Underrepresentation in the workforce impacts the potential supply as well as failing to recognize that, even if we accept the view that women are less likely to enter fields perceived as solitary, lacking personal interaction and needing mathematics, many IT jobs do not fit this image.

The Baby Boomers & Retirement

A phenomenon largely limited to Canada and the USA (and to some degree in the UK), this much-publicized demographic cohort has been at the forefront of the evolution of IT. First entering the workforce in the mid to late 60s, baby boomers made up much of the early IT workforce (which had always been seen as a "young" industry). Now the oldest boomers are almost 60 and their impending retirement may have demographic significance. (Foot, 2000) The SHRC reports that in 2006, 6.4% of the Canadian IT workforce is over 55 and therefore could

retire during the next 10 years. The other part of the baby boom is the "baby bust" -- birth rates following the boomers have been much lower and, without significant immigration, both Canada and the USA would be facing declining populations in the future.

These baby boomers seem less inclined to retire, though they may choose to change the nature of their employment). While the IT workforce is still younger than the average in both Canada and the USA, it is aging and the boomers withdrawal from the workforce will have an increasing impact on the workforce, over the next decade.

6. AN IT EMPLOYMENT MODEL

Based on the detailed discussion above, we can develop an IT employment model (see Exhibit 6). Individuals choose an IT career either in high school or in the early years of their college/university education and, following that education, take an entry-level job in an IT-related occupation. They then advance in their career in the IT field, likely taking part in a variety of education/training activities during their career to stay current, finally retiring at the end of a long career.

This traditional career view is affected by individuals who enter the field without formal training (both to the entry-level and experienced jobs). Additionally, some individuals, despite their IT-related education may take non-IT jobs. For any given country there is likely to be an immigration/emigration effect (permanent or temporary) and the potential for offshored work to either bring-in or lose jobs and even to create new jobs.

From the data reviewed earlier, it seems clear that there is significant entry to the field from all of education; mid-career; and immigration and offshoring. To date, there has been limite exit from retirement due to the relatively young age of the field, but this may soon change as the baby boomers age.

7. SOME TENTATIVE CONCLUSIONS

The Skills Mismatch Seems Real, the Shortage of Workers Less So

There has been considerable evidence of a mismatch between the skills described as necessary by employers and the skills available in the work force.

The North American IT labour market has been in a "tight" state for most of its 40 years, demonstrated by high growth, low unemployment rate and significant job vacancies. However, when viewed from an economist's perspective, describing this as a labour shortage can be seen as an exaggeration, perhaps perpetuated in the interests of the key industry players, due to the absence of many of the factors that normally indicate such a shortage. (Freeman & Aspray, 1999)

There are well-documented problems in the supply of workers with the right skills, although it might be argued that well-educated and experienced workers are available who are capable of having these skills developed.

Despite a long history of claiming the existence of a worker shortage, employers have not been particularly aggressive in making use of the available labour pool. Only a minority of students in the field are given coop or internship opportunities despite the often-stated claim that the best new hire is "a new graduate with 2 years experience". For both entry level and experienced hires, recruitment practices appear to over-focus on current tool skills needed and not on more general experience or abilities, a problem often accentuated by both HR department and recruitment agencies.

There are Entry Level Challenges That Will Likely Increase Over the Next Few Years

At the entry level, the offshoring of junior IT jobs (such work often being done by entry level programmers and end-user support), removes jobs that would previously have been filled by new graduates, thus limiting their opportunities to enter the field.

At the same time, young Canadians and Americans, especially women, are less likely to choose education that will lead them di rectly to IT careers (though we find that later in life, many of them will, in fact, end up in such work). The failure of the community (government, academe and industry)to address this in a comprehensive manner has had a major impact here.

The Use of Immigration Policy as a Method of Resolving Specific Skill

Shortages Does Not Address Fundamental Problems

The use of immigrant worker (permanent or temporary) may be necessary to fill some gaps, but, particularly in the USA, appears to be subject to misuse and may be happening at a level that will impact the continued employment of existing IT workers**.**

While the extent of job loss due to immigration and offshoring is likely exaggerated in most reports, when taken in conjunction with the emphasis on immigration to resolve mid-career skills shortages there should be cause for significant concern.

Industry Needs to Take a More Holistic Approach to the Supply and Development of its Workers

A review of the literature of the last 15 years can only leave a reader with a feeling that, while industry associations and employers have been claiming the existence of a shortage of workers, there has been little concerted effort to resolve these issues. While they express a need for graduates from related programs, only limited opportunity is provided for the student to get the practical experience that is needed to gain employment, with only a small proportion having the opportunity for either internship or coop work. The falloff in female participation has been observed with some dismay over the same period but nothing has been done to address it, unlike in the engineering field.

For the worker in mid-career, employers seem very unwilling to accept that many of the skills needed are overspecified and that reskilling of experienced workers is quite feasible for most IT jobs.

8. RECOMMENDATIONS & FUTURE WORK

Of necessity, this broad-ranging paper must lack depth in specific areas. However, the review has raised issues of supply and demand that are not currently being addressed by government or industry. This lack of action is affecting enrolment at university and career prospects of many. Three areas that seem worthy of both further research and action are:

1. Identifying ways to improve the perception of IT careers amongst high school student, especially women. This seems to be largely ignored by Universities and faculty, who often seem to see their role as educating those who choose to attend, not to be informing and recruiting the talent.

   Specifically, governments, the IT industry and universities should look to the success that has been achieved by the engineering disciplines in increasing female participation.

2. A re-examination of recruitment and staff development methods could also yield some useful insight. For example, the apparent over focus on specific skills in many recruitment activities would appear to be the cause of many of the so-called shortages. This problem is exacerbated by the use of agencies and automated screening of resumes for key words. A better way of identifying core capabilities rather than current buzzwords could have significant effect.

3. There is a need for better partnerships between industry and universities to create and work opportunities for students to gain the practical experience that appears to be so necessary for initial career entry and success. This should include but also go beyond the more traditional routes of coop, internship and graduate intake programs to identify more creative methods.

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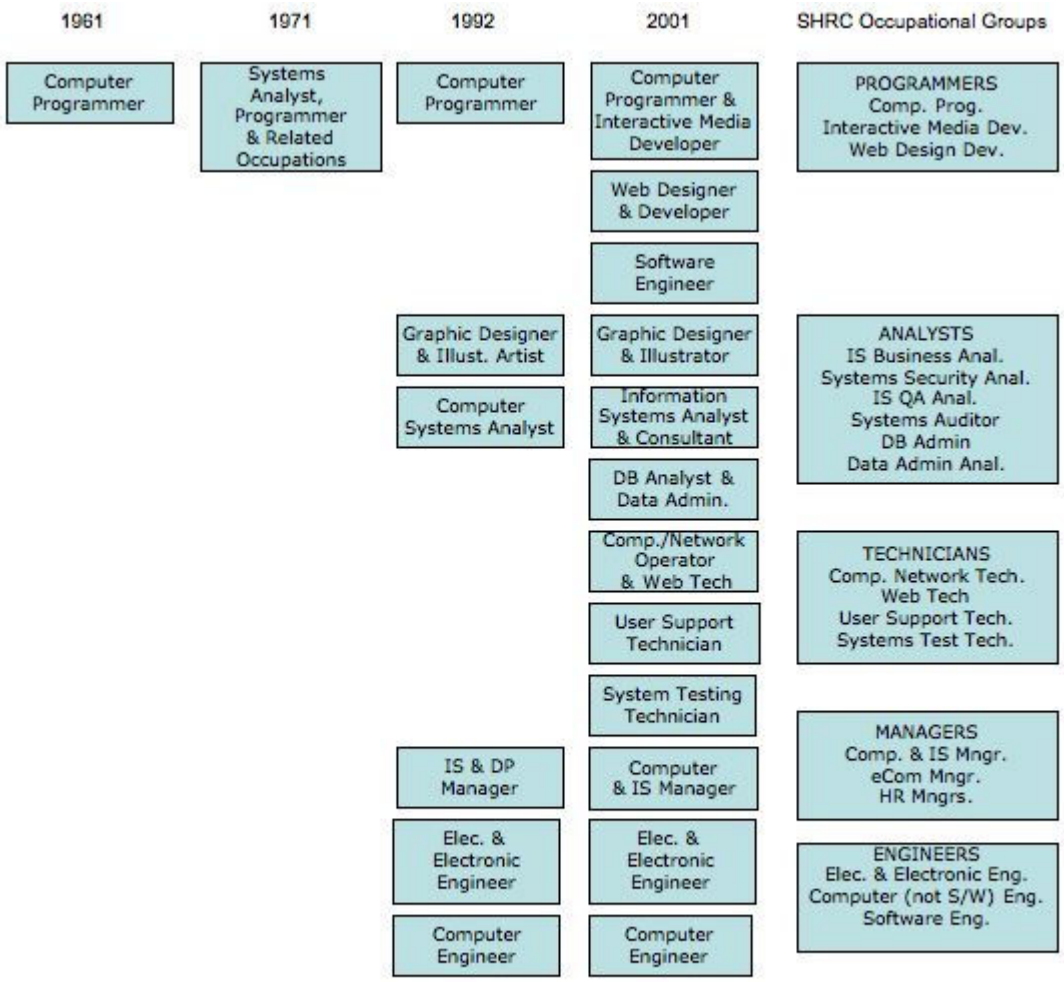

Exhibit 1: The Evolution of IT Job Classification in Canada

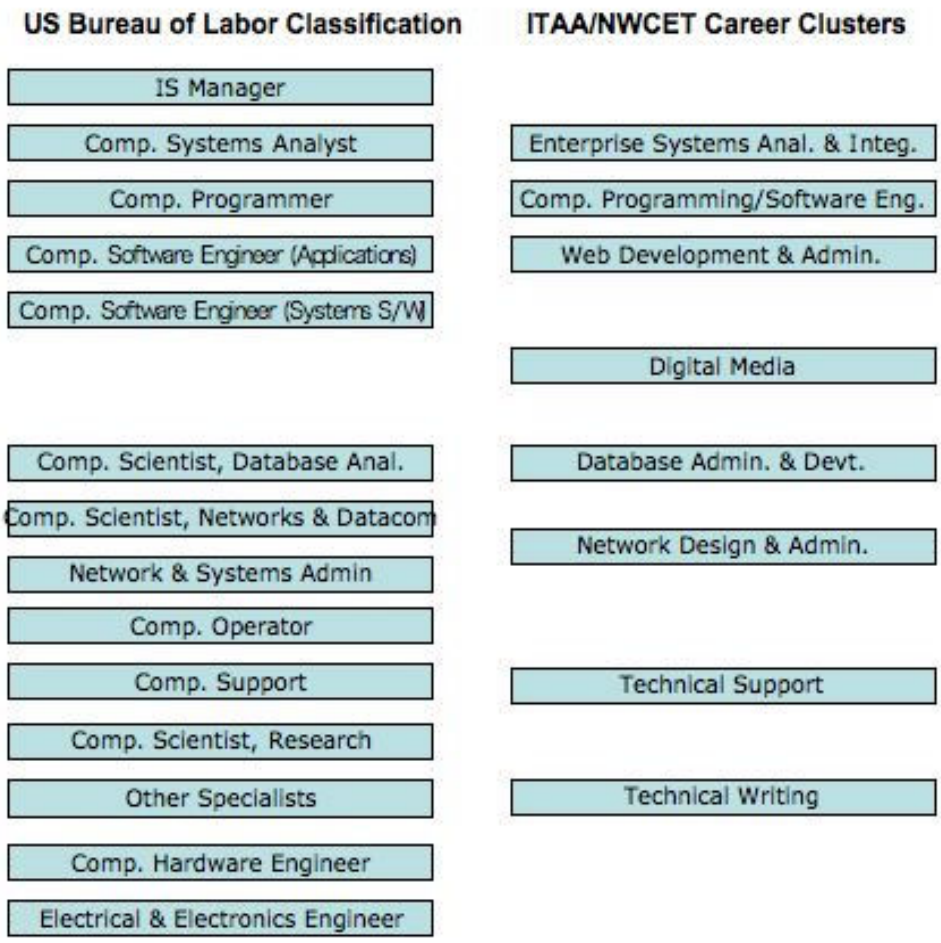

Exhibit 2: US IT Job Classification

Job Type	2005 Workforce	Growth rate	Growth to 2,015	2015 Estimate
IS Manager	280,000	25.9%	72,520	352,520
Comp Systems Analyst	487,000	31.4%	152,918	639,918
Comp Programmer	455,000	2.0%	9,100	464,100
Comp S/W Eng (Apps)	460,000	48.4%	222,640	682,640
Comp S/W Eng (Syst S/W)	340,000	43.0%	146,200	486,200
Comp. Sci. Network & DC	231,000	54.6%	126,126	357,126
Comp. Sci. DBA	104,000	38.2%	39,728	143,728
Comp. Sci. Research	22,000	25.6%	5,632	27,632
Other Specialist	149,000	19.0%	28,310	177,310
Comp Support	518,000	23.0%	119,140	637,140
Network & Sys Admin	278,000	38.4%	106,752	384,752
Comp H/E Eng.	77,000	10.1%	7,777	84,777
Elec & Electronic Eng.	299,000	10.8%	32,292	331,292
Comp. Operator	149,000	-32.6%	-48,574	100,426
Total	**3,849,000**		**1,020,561**	**4,869,561**

Exhibit 5: Projected Growth in IT Workers in the USA

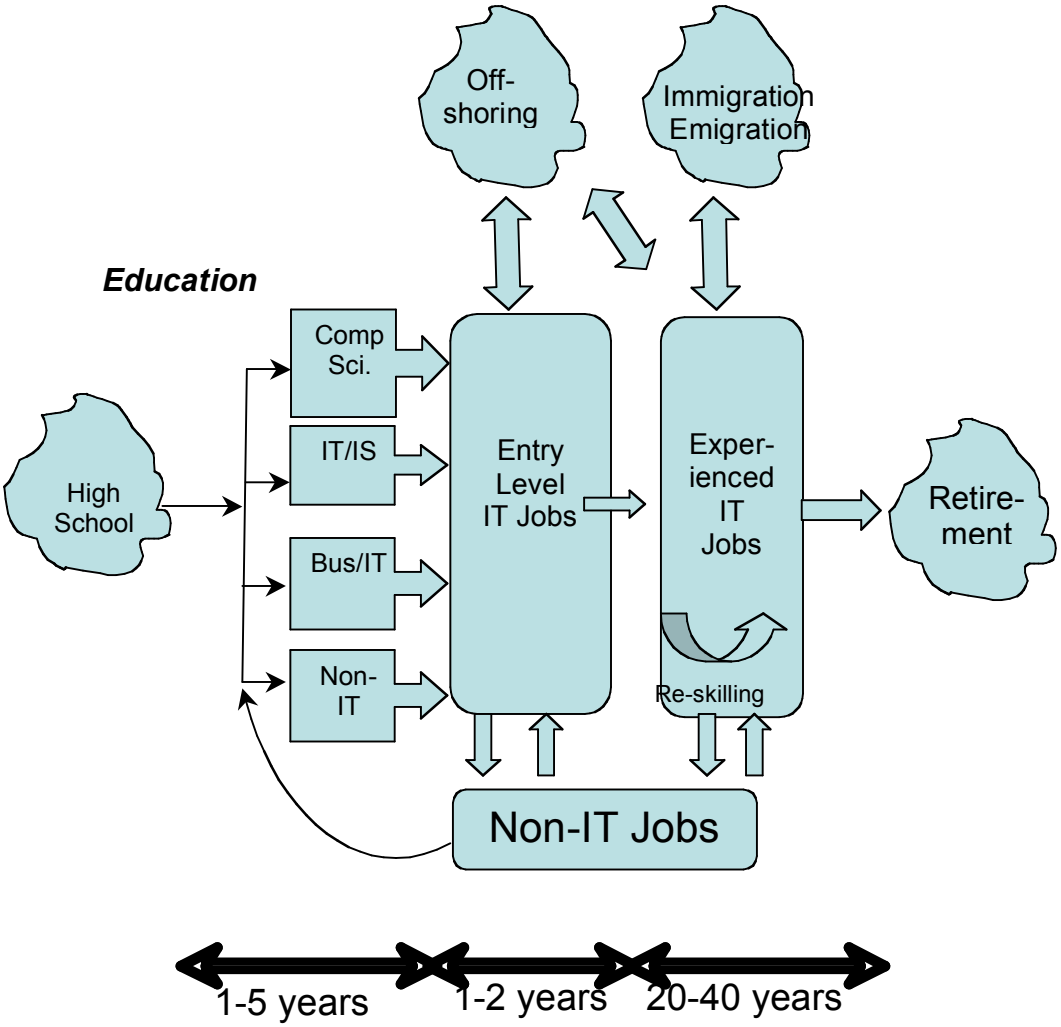

Exhibit 6: An IT Employment Model