

Information Technology (IT) Employment: What is IT?

WANE Working Paper #1

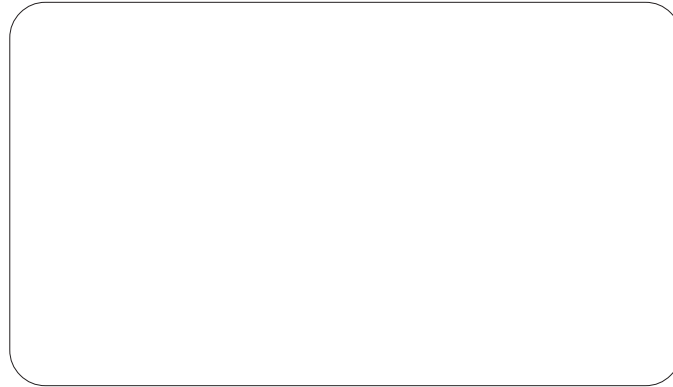
Tammy Duerden Comeau

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Workforce Aging in the New Economy

A Comparative Study of Information Technology Employment



WORKFORCE AGING In The NEW ECONOMY (W.A.N.E.) explores the relationships among workforce aging, employment growth in information technology (IT) labour markets, and the transformation of employment relations in the new economy. This work involves a multi-disciplinary, cross-national comparison of IT employment and workforce aging in Canada, the United States, the European Union, and Australia.

Principal Investigator:
Julie McMullin, Ph.D.

Project Manager:
Terri Tomchick, MA

Workforce Aging in the New Economy

The University of Western Ontario
Social Sciences Centre, Room 3207
London, Ontario CANADA
N6A 5C2

t: 519-611-2111 x.81236

f: 519-661-3200

e: wane@uwo.ca

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Tammy Duerden Comeau
Workforce Aging in the New Economy
University of Western Ontario
London, ON CANADA

Abstract

‘Information technology’ is a term that has been used in a number of different ways by academics, governments and professional organizations. This paper gives a brief history of how the term ‘information technology’ has been conceptualized and the challenges that this task has posed for researchers. This examination of some of the key debates and difficulties surrounding the definition of ‘information technology’ situates our project’s working definition of the term in a broader context. The issues of ‘diffusion’ and ‘convergence’ and the academic dialogue over the related term ‘information society’ are touched upon. The bulk of the paper is devoted to examining IT industry and IT occupational definitions. In the effort to define IT and ICT industries, the pioneering work done by the Organization for Economic Co-operation and Development (OECD) is highlighted. The process of ‘convergence’ between communications, technology and electronics complicates attempts to measure and quantify industry growth. Our interest is chiefly with the burgeoning ‘high-tech’ component of the IT industries. Therefore, we have limited our IT *industry* definition to a focus on software and computer services included under the North American Industry Classification 54151.

Understandings of the ‘IT worker’ present an even more varied spectrum with some definitions extending to include all workers who contribute to the IT infrastructure (e.g. data-entry keyers) and/or all IT ‘users.’ Our main focus is on the highly skilled IT worker or the “core” IT occupations. These workers primarily deal with the programming, analyzing and engineering of computer software. Our IT occupational definition will explicitly use the National Occupational Classification (NOC) system newly developed by Human Resources Development Canada and the Software Human Resource Council. This definition includes 21 IT occupations that are defined as “those whose primary functions are the management, design, development, analysis, implementation or maintenance of computer telecommunications hardware, software, networks or information systems” (SHRC/HRDC, 2001, p. 9). This classification system is able to grow and adapt with the rapidly changing face of information technology occupations. In addition, this definition of IT workers is being used in a large-scale national occupational survey undertaken by Statistics Canada, thus enabling us to compare our findings.

Introduction

What is meant by the term ‘information technology’ or IT? This paper examines the definitions and uses of the term information technology (IT) with the purpose of developing a working definition for the Workforce Aging in the New Economy (WANE) project. This will be a definition for measurement purposes, in the sense that it will dictate the boundaries of the IT industry and occupations to be analyzed in this study. This paper will begin with a brief examination of some of the broader conceptualizations of IT found in academic circles and in OECD (Organization for Economic Cooperation and Development) documents. The remainder of the paper will focus on what may be termed the ‘technical’ definitions (or formal classification systems) of what constitutes the ‘information technology’ industry and ‘information technology’ occupations. This is an important distinction to make, particularly when defining IT workers, as the information technology ‘sector’ or industry definition includes *all* employees who work in the industry (e.g., sales representatives, janitors, etc.), while the ‘occupational’ definition of information technology looks at IT workers across *all* sectors (CEPIS, 2002; NTO, 2001).

The process of measuring information technology is complicated by the speed of technological innovations and the processes of ‘convergence’ and ‘diffusion’ (Freeman & Aspray, 1999; Miles & Kimbel, 1993; OECD, 1992; OECD, 1981). ‘Diffusion’ refers to the “pervasive” nature of IT and the degree to which information technology is used in many different industrial sectors and by those in diverse occupations (Arnold & Guy, 1989, p. 135). Miles & Kimbel (1993, p. 78-79) note that, in Canada, Germany, and the U.S, communications, finance, and

business services represent the most avid industry users of IT. A 1998 OECD study also found that workers in the finance and insurance industries were the strongest users of information technology in the workplace (OECD, 1998, p. 3). In Canada, eighty-five percent of IT jobs are clustered in five industry sectors; professional and technical services (representing the majority), manufacturing, information and culture, finance and insurance, and public administration (Wolfson, 2002, p. 20). A number of studies differentiate between those who develop and produce IT in a highly skilled capacity and those who use IT in their job (albeit often in highly skilled ways) (ACS, 1993; Freeman and Aspray, 1999). For example, in Australia, the IT& Titab (Information Technology and Telecommunications Industry Training Advisory Body) differentiates between ‘IT specialists’ and ‘IT users’ (ACS, 1993). The multiple definitions that have been developed to pinpoint the ‘IT worker’ will be explored in the IT occupation definition section. It is important to note that the present study is chiefly concerned with IT workers (both in the IT industry and across sectors) and with workers employed by IT firms; however, the *use* of IT by those in non-IT occupations is not the focus in this investigation.

Convergence is defined as “the blurring of technical and regulatory boundaries between sectors of the economy” and it is chiefly a stumbling block for industrial classifications of IT (OECD, 1992, p. 13). Appendix A, Table 1, shows a mid-twentieth century snapshot of some of the technological growth and ‘boundary blurring’ that has taken place over this time period (Arnold & Guy, 1989, p. 152). Issues surrounding the ‘convergence’ of the computing, electronics, telecommunications, and broadcasting sectors make it difficult to create clear-cut

industrial classifications of information technology. In fact, while most of the OECD literature throughout the 1980s and 1990s discusses 'Information Technology' or IT, there appears to have been some shift to using the term 'Information and Communications Technology', or ICT. The convergence of communications with the information technology sub-sector led to the wider conceptualization of IT as ICT. In the OECD document, *Information Technology Outlook 2000*, they explain that:

Over the years, the IT sector has been defined in various ways...Existing standard statistical classifications and systems (both national and international) have been unable to keep up with the rapidly changing character of IT goods and services and IT firms. Now, with convergence of computing and telecommunication technologies, these sectors are often classified into a combined information and communication technology (ICT) sector (OECD, 2000, p. 249).

Therefore, the convergence of technology and communications has led to the broader term (ICT), and, in the United Kingdom, the classifications have been broadened still further with the conceptualization of the ITEC sector (which includes the convergence of electronics) (NTO, 2001). The present study takes a narrower approach, as the primary aim is not to assess the broad diffusion and convergence of ICT but to home in on the experience of highly-skilled IT workers and on work experience in IT-specializing firms. This approach means that our industry focus is not on ICT as a whole, but specifically on the IT portion, or the software and computer services portion, of the industry. The

rationale for this decision will be explored in more detail in the industry section that follows.

Academic Context

In academic circles, debates surrounding the broader term, 'Information Society', appear to be far more common than debates over the definition of information technology. There is no clear agreement on what an 'Information Society' is, or on whether we are currently in one; however, information technologies are frequently given a key role in this dialogue (Webster, 1994). For instance, the Advisory Council on Science and Technology in Canada notes that the Information and Communication Technology sector is often characterized as the "engine of the knowledge industries" (Canada Advisory Council on Science and Technology, 2000, p. 23). Still, the terms in these discussions are difficult to pin down. In fact, breaking down the term and taking each word in isolation (e.g., providing definitions of information or technology) complicates the matter further (Webster, 1994). Poirier (1990, p. 246) reviews a number of definitions of 'information,' and concludes that 'information' per se does not characterize the "Information Society." Instead, it is the "digitization of information" that signals a new phenomenon. Defining 'technology' is equally challenging. Technology definitions may range from more general considerations of "practice" to more specific concerns with the materials employed and/or the "social relations" underlying the technological process (Berg, 1994, p. 94; Franklin, 1990). Researchers have distinguished between levels and forms of technology (Franklin, 1990; Smith Keller, 1992). For example, Castells' (2000, p. 6) gives a more specific definition of technology as "the use of scientific knowledge to specify ways of

doing things in a reproducible manner.” A brief examination of these terms shows the extent to which theorists and researchers disagree over understandings of ‘information’ and over the meaning of ‘new technologies’ in contemporary society (Poirier, 1990; Webster, 1994).

The term “Information Society” was first coined in Japan in the mid-1960s. Since then, a proliferation of theories on the principles and properties of “Information Societies” has followed (Duff, Craig & McNeill, 1996; Parjo, 1999; Ricci, 2000). Webster (1994) argues that most theories of the ‘Information Society’ treat information as a purely quantitative phenomenon, devoid of meaning and context. He advocates a qualitative understanding of information. Not all theories of ‘information’ ignore the contextual element, as Gault’s (1999, p. 1) definition of ‘information’ explicitly defines it as “data in context.” In many conceptualizations of the ‘Information Society,’ IT represents the catalyst and director of social change (Webster, 1994). For example, although Castells’ (2000, p. 5-9) analysis of society presents a complex view of societal processes, he still sees the “new information technologies” as the impetus of what he calls the “Information Age.” Other theorists have criticized the tendency to consider ‘technologies’ as the causal factor in stimulating societal change, arguing that this tendency is overly deterministic. Critics note that technological innovations are equally shaped by existing economic and social organizations (Sassen, 2002; Wajcman, 2002, p. 348). Golding (2000, p. 165) argues that it is biotechnology that is “wholly new” and ‘information technologies’ are better viewed as refinements of previous technologies rather than as a break with the past.

Despite the plethora of theories on the “Information Society,” Ricci (2000, p. 145) notes that all seem to agree on the idea that “we are witnessing a historic cycle characterized by considerable (and undisputable [sic]) computer/network-centric innovation.” It is worth noting that, in many discussions of the “Information Society,” IT is conceptualized as a key component and indicator of this new era; however, it is rarely explicitly defined (Webster, 1994). While a number of academic writings address the issues surrounding the impact that technology is having on society (and increasingly vice versa), they are not a rich source for IT definitions. The focus in this paper is on the term IT and not ‘Information Society’ or on ‘Information Economy’ (terms in which discussions of information technology are frequently embedded) (Arnold & Guy, 1989; Castells, 2000; Miles & Kimbel, 1993; OECD, 1997; Webster, 1994).

International Context/OECD focus

ICT Industry Definition

The Organization for Economic Co-operation and Development (OECD) has been developing conceptualizations and measurements of information technology for over twenty years. Much of this work has been generated by the Committee for Information Computer Communications Policy (ICCP) and the Working Party on the Information Economy. Appendix A, Table 2 outlines some of the earlier OECD IT definitions.

In order to compare and evaluate the growth and dispersion of information and communications technology, international measurement indicators had to be agreed upon. The OECD made the definition and classification of the ICT sector a priority

(Gault, 1999). Many OECD countries played a part in their development. For example, in 1996, Industry Canada, Heritage Canada, the Department of Finance, and Statistics Canada partnered to produce a document with comparable information technology indicators in mind (Industry Canada, et al., 1996). In Canada, prior to 1997, the Canadian Standard Industrial Classification System (SIC) was used to classify the ICT sector; however, the dichotomy in this system between manufacturing and services presented a problem. The authors note the arrival of the North American Industry Classification System in 1997 (NAICS) as a significant step towards increased comparability between nations. In this document, they define “the ICT services sector as including broadcasting, telecommunication carriers, computer services and the ICT goods sector as including communication and electronic equipment, computing and peripheral equipment, office, store and business machines” (Industry Canada et al., 1996, p. i; see Appendix B, Chart 1 for classification). This is a broad conceptualization of the ‘information society’ in that content-producing industries, like broadcasting, are included in the services sector. Ultimately, the OECD excluded content-and/or information-producing industries, instead focusing on the producers of software and hardware services and equipment (Gault, 1999; see Appendix B Table 1, for a selection of national IT/ICT definitions).

The OECD approached the definition-making process of the information and communications technologies (ICT) industries by taking an expansive approach and by deciding what products could be classified as ICT and then referencing the appropriate industry classification (Gault, 1999). In 1998, the ICT definitions that were

agreed upon were as follows: the ICT sector was defined as “a combination of manufacturing and services industries that capture, transmit and display data and information electronically” (OECD, 2002, p. 81). The determination of ICT products was made according to the following guidelines:

Manufacturing

The products of a candidate industry must:

be intended to fulfill the function of information processing and communication, including transmission and display; or use electronic processing to detect, measure and/or record physical phenomena, or to control a physical process. Components primarily intended for use in such products are also included.

Services

The products of a candidate industry must:

be intended to enable the function of information processing and communication by electronic means; and, the service provided must go beyond simply the supply of goods.

Source: OECD, 2002, p. 81; see *Appendix B, Chart 2*

The OECD industry definition is based on the International Standard Industrial Classification (Rev. 3) and concordances were developed for national ICT definitions (OECD, 2002; Statistics Canada, 2001; see Appendix B, Charts 3-8 for concordance tables and national detailing of ICT definitions). The European classification system for industry is called NACE (Nomenclature generale des Activites economiques dans la Communaute Europeenne) and is considered to be

“essentially identical” with the ISIC system (CEPIS, 2002, p. 36).

The concordances are somewhat more complex for the North American and Australian data (OECD, 2002). April (1999, p. 3) highlights the differences between Canada’s SIC system and the new OECD definition as follows: radio and television broadcasting are excluded, wholesalers and lessors of ICT equipment are included, and insulated wire and cable manufacturers are included. Canada and the United States have recently switched to the North American Industrial Classification System (NAICS); the NAICS classification system is better equipped to measure the ICT sector, as it can account for the development of new industries and technological innovations (Statistics Canada, 2001; see Appendix B, Chart 8 for some ICT industry definitions of participant countries; see Chart 9 for Statistics Canada ICT definition). Industry Canada (using the NAICS definition) breaks down the ICT sector into two components: (1) ICT manufacturing (including computer equipment mfg, communications equipment mfg., audio and video equipment mfg., electronic component mfg., instruments mfg., communication wire and cable mfg., and commercial industry machinery mfg.); and (2) ICT wholesaling and ICT services (including software and computer services, telecommunications services and cable and other program distribution) (Industry Canada, 2002c). In the selection of case studies for IT firms, this study will consider those businesses that are classified under the NAICS 54151 industry definition (Computer Systems Design and Related Services; see Appendix B Table 2 for a detailed description of this portion of the ICT sub-sector).

Employment growth in the ICT sector has been overwhelmingly due to the growth in

ICT services (OECD, 2002; OECD, 2000). In the OECD member countries between 1995-2000, ICT manufacturing employment has declined; however, ICT services employment has increased everywhere with the exception of Austria (OECD, 2002, p. 24). Employment growth in the software services is described as the most “dynamic component” in this increase (OECD, 2002, p. 24). In the OECD statistical profiles of Australia, Canada, United Kingdom and the United States, ICT employment growth is led by the computer services sub-sector (OECD, 2000). In the Canadian context, the ICT services industry output increased by 12% in 2001, while the manufacturing output declined by 28.3% in the year (Industry Canada, 2002a, p. 1). Industry Canada (2002a, p. 1) estimates show that employment growth within the software and computer services industries had the biggest increase in 2001 (adding 25,000 new jobs; see Appendix C, Table 1 for an employment breakdown by ICT sector).

Data for the provincial level show that Ontario has the largest concentration of ICT, where ICT employment accounted for more than 4% of total regional employment (ICT Sector Regional Report (SRR), Industry Canada, 2002b, p. 33). In fact, the Software and Computer Services Industries employed half (50%) of all those working in the ICT sector in Ontario in 1999 (Industry Canada, 2002b, p. 19). Software and Computer Services firms represent 97% of ICT sector establishments in Ontario and in Alberta (Industry Canada, 2002b, p. 18, 26). In Ontario, these firms generated revenues of nearly 12.6 billion dollars in 1999 (Industry Canada, 2002b, p. 18). The NAICS 54151 accounts for the bulk of highly-skilled workers in this sub-sector and our narrowed focus on this one industry will allow us to compare more readily across regions and countries.

IT Occupational Definition

Occupational definitions for IT workers present an even more varied definitional spectrum, as there is no internationally agreed upon classification system for IT occupations (or ICT occupations); therefore, even within countries, diverse estimates are generated on the composition of the 'IT workforce' (CEPIS, 2002; Committee on Workforce Needs in Information Technology, 2001; OECD, 2002; Stager, 2001; see Appendix D, Table 1 for a sampling of U.S. IT worker definitions). Miles and Kimbel (1993, p. 59) argue that the "the two major classes of IT-producing occupations are: electronic engineers and related professions and programmers and systems analysts." These authors also point out that cultural differences play a role in national occupational classifications (Miles & Kimbel, 1993). For example, Canada includes 'transport managers' under the category of telecommunications managers, thus leading to a large number of 'IT workers' in the transport sector (Miles & Kimbel, 1993, p. 61). It is important to note that IT workers are not confined to the IT/ICT industry (CEPIS, 2002; see Appendix D, Table 2 for a comparison of IT firms vs. IT-user organizations employment of IT workers).

Information technology-related occupations cover a broad range of tasks and skill-levels (Cooke, 2002; see Appendix D, Chart 1 for U.S. skill grouping). For example, telephone operators and data-entry keyers are classified under IT-related occupations in the United States' most recent *Digital Economy* report, because all occupations that aid and contribute to the "IT infrastructure" are counted as IT occupations (Cooke, 2002, p. 44). The OECD differentiates between high-skill and low-skill ICT occupations, noting that the greatest number of skilled

ICT workers are 'computer workers' (OECD, 2002, p. 16). The OECD uses the International Occupational Classification System (ISCO) in its measurement of European ICT workers (the Eurostat Labour Force Survey (LFS) uses this system as well) (CEPIS, 2002; OECD, 2002; see Appendix D, Chart 2 for a detailed description of ISCO 'computer workers'). The ISCO classification system used by both the OECD and the Eurostat LFS considers 'Computing Professionals' (ISCO 213) and 'Computing associate professionals' (ISCO 312) to comprise the more highly skilled ('computer worker') IT workforce (CEPIS, 2002, p. 35; see Appendix D, Tables 3 & 4 for Eurostat LFS data on IT occupations on a selection of European countries). However, the Council of European Professional Informatics Societies Study (CEPIS) notes that ISCO 312 (which includes photographers and image and sound recording equipment operators, broadcasting and telecommunications equipment operators, etc.) is classified as a "non-professional IT occupation" (CEPIS, 2002, p. 35). In the CEPIS IT practitioner study, the researchers define an IT practitioner as "someone who designs, develops, operates, maintains, supports, services, and/or improves IT systems, in support of End-Users of such systems" (CEPIS, 2002, p. 34). This classification is representative of the use of a "core" IT worker definition in many national labour force data collections (CEPIS, 2002, p. 37; Committee on Workforce Needs in Information Technology, 2001).

The United Kingdom Labour Force Survey and the United States Bureau of Labour Statistics use their own Standard Occupational Classification Systems (which underwent recent revisions from SOC90 to SOC2000) (CEPIS, 2002; Cooke, 2002). These systems use a narrow definition of IT

workers built around a 'core' group of computer workers (see Appendix D, Charts 3-6 for UK and US and Australian SOC categories). The Canadian Census has typically used three occupational groups to classify IT workers; computer engineers, systems analysts, and computer programmers (Wolfson, 2002, p. 1). However, these standard occupational classification systems tend to be too static to capture the changing landscape of IT and the on-going creation of new IT tasks (CEPIS, 2002; Freeman and Aspray, 1999). The New Standard Occupational Classification System was implemented in 1999 by the U.S. Bureau of Labor Statistics in order to address the ongoing changes in the field (Cooke, 2002). For example, this new system splits the category 'computer engineers' into 'computer hardware engineer, computer software engineer-applications, and computer software engineer-systems software' and adds a number of 'new occupations' such as, network and computer systems administrators, and network systems and data communication analysts (Cooke, 2002). Still, the existing occupational classification systems are thought to be largely inadequate to the task of charting information technology jobs (Committee on Workforce Needs in Information Technology, 2001). For example, the Information Technology National Training Organization in the U.K estimates that the Labour Force figures for IT-related workers lead to an underestimation of forty percent, because many occupations are excluded (e.g. electronics engineers, creative media) (NTO, 2001, p. 13).

The new emphasis in information technology 'occupational' classifications is on 'skills' and 'what these workers do' (Stager, 2001; Wolfson, 2002). This has led to the development of skill-based

classification frameworks, although the newness of these frameworks means that few existing studies of the IT workforce use skill-based systems (CEPIS, 2002; NTO, 2001; SFIA, 2000; SHRC/HRDC, 2001; see Appendix D, Table 5 for U.K IT worker estimates based on differing classification systems). The U.K. has developed the SFIA framework (Skills for the Information Age), whereby work categories, skills, and responsibilities are merged into a common classification system (NTO, 2001, p. 6; see Appendix E, Table 1 for selection of SFIA framework). However, for practical measurement purposes, purely 'skill-based' classification systems are difficult to quantify (Committee on Workforce Needs in Information Technology, 2001).

Rationale for Using NOC-Based IT Worker Classifications

Canada has also developed a new occupational classification framework (NOC) that takes account of IT skills through the newly developed Occupational Skills Profile Model (OSPM) and is therefore able to adapt to the changing framework of IT growth imperatives (SHRC/HRDC, 2001; Wolfson, 2002; see Appendix E, Table 2 shows the integration of skill levels into the NOC system). Human Resources Development Canada and the Software Human Resource Council partnered in 2002 to produce the new National Occupational Classifications System (NOC), in which 24 job streams and 21 IT occupations have been targeted (Wolfson, 2002; see Appendix E, Table 3 for 24 job streams and Table 4 for 21 occupations). In this conceptualization, IT occupations are defined as "those whose primary functions are the management, design, development, analysis, implementation or maintenance of computer telecommunications hardware, software,

networks or information systems” (SHRC/HRDC, 2001, p. 9). The NOC system, which formed the basis for the IT occupations presently being surveyed by Statistics Canada in the Canadian National Survey of Information Technology Occupations, will be used for our definition of IT workers (see Appendix E, Chart 1 for a list of IT occupations).

This classification system is the first of its kind in Canada, and has been endorsed by the Federal Government, having already been used to re-analyze Canadian Labour Force Statistics data (SHRC/HRDC, 2001; Wolfson, 2002; see Appendix E, Tables 5 & 6 for data on the IT occupations analyzed in the LFS and current IT occupational estimates). The LFS data show the extent to which shifts occur in IT occupations (SHRC/HRDC, 2001, p. 3). For example, the occupation of interactive media developers grew from 1,700 in 1999 to 17,000 in the year 2000 (SHRC/HRDC, 2001, p. 2). In addition, two existing IT surveys have utilized the NOC system and an extensive Statistics Canada National IT Occupational Survey is also in process (O’Grady, 2000; Statistics Canada, 2002).

In summary, although there is significant variation in how IT occupations have been classified in various countries, the key advantage of the recent Canadian classification scheme is its explicit focus on highly skilled IT professionals using the well established NOC coding system. A second advantage of this scheme is that a current profile of IT exists in Canada that can be used as a benchmark for cross-national comparisons. Hence, the WANE project will adapt the Canadian IT classification scheme in its work.

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Appendix A, Table 1
 Some Key Events in the Convergence of Information Technology
 adapted from Arnold & Guy p. 152 (1989)

Year	Communication Technologies	Information Technologies	Computer Technologies
1940-50	Military mobile radio, Radio		single-function computers, general-purpose computers
1950-60	video tape recording, direct distance dialing, crossbar switching, microwave links, cable tv, tape recording		commercial computers, programming languages, transistor
1960-70	electronic switching, digital communications, communications satellites		integrated circuits, minicomputers, structured programming
1970-80	facsimile transmission, mobile radio, packet switching, teletex, videotex, optical fibre, video disks, teleconferencing	online enquiry, professional databases, management information services, integrated text and data processing, transaction cleaning systems, professional problem-solving	data base management systems (dbms), applications generation, microprocessors, relational dbms, spreadsheets, VLSI
1980-90	local area networks, cellular radio, wide area networks, private satellites, integrated service digital networks, personal telephones		portable computers, logic languages, optical disk storage, transputer, expert systems, voice recognition, dataflow processors, wafer scale integration, gallium arsenide chips, parallel processing, learning capability,
1990-2000	switched wideband services, personal mobile communications (via satellite)		natural language recognition, optical chips, biochips, ultra-intelligent machines

Appendix A

Table 2, Some OECD IT definitions

Paper	Definition
(ICCP) <i>Information Activities, Electronics and Telecommunications Technologies: Impact on Employment, Growth and Trade</i> vol. 1, OECD, 1981	<p>'the term 'information technologies' refers to the powerful systems created by the combination of computer and communication technologies." (p. 71)</p> <p>*in a footnote "new 'information technologies' ...by this we mean the <i>convergence</i> of computer, telecommunications and office-machine systems and technologies" (p. 72) (my emphasis)</p>
(ICCP) <i>Information Technology and Economic Prospects</i> , OECD, 1987 by Dieter Kimbel and Paul Stoneman	<p>* "the term 'information technologies' is used throughout this study to cover technologies used in the collection, processing and transmission of information. It covers inter alia, computers, electronic office equipment, telecommunications, industrial robots, and computer controlled machines, electronic components and software products...three particular characteristics of IT innovationsminiaturisation; expanded capacities; reduced costs" (p. 12)</p>
An analytical framework for analysing the impact of information technologies on economic perspectives by Paul Stoneman (within above ICCP document)	<p>* "information technology may be broadly defined as 'products and processes concerned with the collection, transmission and manipulation of information.' It covers, among other things, computers, telecommunications, robotics and micro-electronics" (p. 70-1)</p>
(ICCP) <i>Information Technology and New Growth Opportunities</i> , OECD, 1989	<p>* "the term 'information technology' is used in this paper to cover all technologies used in the collection, storing, processing and transmission of information, including voice, data and images. This includes microelectronics and other opto-electronics dependent on them..." (P. 11)</p>

Appendix B, Chart 1

Based on Standard Industrial Classification-1980

Industries included in the ICT sectors

Sector	SIC	Description
Service	481	Telecommunication Broadcasting Industries
		4811 Radio Broadcasting Industry
		4812 Television Broadcasting Industry
		4813 Combined Radio and Television Broadcasting Industry
	4814 Cable Television Industry	
	482	Telecommunication Carriers Industry
	483	Other Telecommunication Industries (e.g. Paging)
	772	Computer and Related Services
		7721 Computer Services
		7722 Computer Equipment Maintenance and Repair
Goods	334	Record Player, Radio and Television Receiver Industry
		3341 Record Player, Radio and Television Receiver Industry
	335	Communication and Other Electronic Equipment Industries
		3351 Telecommunication Equipment Industry
		3352 Electronic Parts and Components Industry
	3359 Other Communication and Electronic Equipment Industries	
336	Office, Store and Business Machine Industries	
	3361 Electronic Computing and Peripheral Equipment Industry	
	3362 Electronic Office, Store and Business Machine Industry	
	3368 Store and Business Machine Industry	
	3369 Other Office, Store and Business Machine Industries	
391	Scientific and Professional Equipment Industries	
	3911 Indicating, Recording and Controlling Instruments Industry	
	3912 Other Instruments and Related Products Industry	

Source: Industry Canada, Heritage Canada, the Department of Finance and Statistics Canada, 1996: 37

Appendix B, Table 1

Country	IT/ICT Industry definition
Australia	<p><i>The Information Technology Industry is defined as the development and application of computers and communications-based technologies for processing, presenting and managing data and information. This includes computer hardware and component manufacturing; computer software development and various computer related services; together with communications equipment, component manufacturing and services. (The ACS Towards 2000, Taskforce Report)</i></p> <p><i>The IT&T sector is that part of the economy which produces information technology and telecommunications goods and services. It includes businesses involved in telecommunication services, computer services, and selected manufacturing and wholesale trade industries. (ABS Year Book Australia Special Article – The Information Society and Information Economy in Australia, 1999 ABS CAT NO:1301.1.01)</i></p>
Canada	<p><i>The ICT manufacturing segment is defined as those industries that manufacture hardware components of the ICT sector, composed chiefly of consumer electronics, communication and other electronic equipment industry, computer equipment, communications and energy wire and cable, and instrumentation. The ICT services segment includes communications industries, ICT wholesaling, and software and computer services.the selection of these industries is based on a recognition that opportunities for people skilled in ICT exist in almost every segment of the economy, but are perhaps more highly concentrated in these selected industries. (Denton & Pereboom, 1999:3-4)</i></p> <p><i>Information Technology- Computer, telecommunications and video technology used to acquire, process, store and disseminate information (vocal, pictorial, textual or numerical) (O'Grady, 2000: 65)</i></p> <p><i>For years the term 'information and communication technologies' (ICTS) has been widely used to describe both the fast-paced, new-growth industrial segment of the economy, as well as the continuous introduction of new technologies that foster the information society. (Statistics Canada, 2001:12)</i></p>
United Kingdom	<p><i>ICT definition: ICT is the technical toolkit, including the hardware, software, networks, tools, telecommunications equipment and required standards. It is the technological framework on which the delivery of information services is based. The specification, design, development and operation of the technical infrastructure are the concern of technical service providers. (E-Skills, 2002: 7)</i></p> <p><i>ITEC : includes consumer electronics, electronic measures and scientific instruments, computer equipment, broadcast network equipment, basic networks, enhanced voice and data networks, networking services, broadcasting services, digitised content, software (NTO, 2001: 3)</i></p>
United States	<p><i>The IT producing industries selected for the DE 2002 report are those industries that produce, process, or transmit information goods and services as either intermediate demand (inputs to production of other industries) or as final products (goods and services bought by consumers, business investors, government or for exports). The selected IT-producing industries also include those that supply the goods and services necessary for the Internet and electronic commerce (e-commerce) to operate i.e. provide the products and services for the Internet infrastructure. IT-producing industries include manufacturers of some general and specialized electronic components, computers and peripheral equipment, specialized measuring and testing instruments, telecommunications equipment, and prepackaged software. IT-producing industries also include computer, software, and telecommunications service providers.(excluded content industries) (Source: Cooke, 2002: 1)</i></p> <p><i>In this discussion, information technology (IT) refers only to computer-based systems. It includes computer hardware and software, as well as the peripheral devices most closely associated with computer-based systems. We define 'computer-based systems' broadly to include the full gamut of technological considerations, ranging from the design and production of chips; through the design and creation of complex, computer-based systems for a particular application; to the end-use of such systems...</i></p> <p><i>The term 'information system' is sometimes used to refer to computer-based systems that provide information for decision making in organizations, which results in the use of 'information technology' and 'information systems' in closely related ways.in this report, the underlying technology of an information system is considered to be an example of information technology (Freeman & Aspray, 1999: 25)</i></p>

Appendix B, Chart 2

OECD definition, ISIC rev. 3

Industry Groupings	ISIC	Industry Titles
Manufacturing	3000	Manufacture of office, accounting and computing machinery
	3130	Manufacture of insulated wire and cable
	3210	Manufacture of electronic valves and tubes and other electronic components
	3220	Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy
	3230	Manufacture of television and radio receivers, sound or video recording or reproducing apparatus, and associated goods
	3312	Manufacture of instruments and appliances for measuring, checking, testing, and navigating and other purposes, except industrial process control equipment
	3313	Manufacture of industrial process control equipment
Goods related services	5150	Wholesale of machinery, equipment and supplies
	7123	Renting of office machinery and equipment (including computers)
Intangible services	6420	Telecommunications
	7200	Computer and related activities

Source: April, 1992:2 (Statistics Canada)

Appendix B, Chart 3
 Concordance between ISIC and SIC80
 ICT sector – concordance for reporting purposes – 1980 SIC

ISIC3	ISIC title	SIC80	Canadian 1980 title
3000	Manufacture of office, accounting and computing machinery	3361	Electronic computers & peripheral equipment
3130	Manufacture of insulated wire and cable	3362	Electronic office, store & business machine industry
3210	Manufacture of electronic valves and tubes and other electronic component	3369	Other office, store & business machine industries
3220	Manufacture of television and radio receivers and associated for line telephony and line telegraphy	3381	Communications & energy wire & cable industry
3230	Manufacture of television and radio receivers, sound or video recording or reproducing apparatus, and associated goods	3352	Electronic parts and components industry
3312	Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process control equipment	3351	Telecommunications equipment industry
3313	Manufacture of industrial process control equipment	3359	Other electronic equipment industries
5150	Wholesale of machinery, equipment and supplies	3341	Record players, radio & TV receivers industry
6420	Telecommunications	3911	Indicating & recording instruments industry
7123	Renting office machinery and equipment (including computers)	3912	Other instruments and related products
7200	Computer and related activities	5743	Elec. machine, equipment & suppl (esc. Comp) wholesale
		5744	Computer & related mach, equip & software, wholesale
		5791	Office and store machinery, equip. & sales, wholesale
		4814	Cable television industry
		4821	Telecommunications carries industry
		4839	Other telecommunications industry
		9913	Office furniture & machine rental & leasing
		7721	Computer services
		7722	Computer equipment maintenance & repair

Source: April, 1999: 5 (Statistics Canada)

Appendix B, Chart 4

Concordance between ISIC and NAICS, ICT sector-concordance for reporting purposes-NAICS

ISIC3	ISIC title	NAICS	NAICS title
3000	Manufacture of office, accounting and computing machinery	33331	Commercial & service industry machinery manufacturing
3130	Manufacture of insulated wire and cable	33411	Computer & peripheral equipment manufacturing
3210	Manufacture of electronic valves and tubes and other electronic component	33592	Communications & energy wire & cable industry
3220	Manufacture of television and radio receivers and associated for line telephony and line telegraphy	33441	Semiconductor & other electronic component industry
3230	Manufacture of television and radio receivers, sound or video recording or reproducing apparatus, and associated goods	33421	Telephone apparatus manufacturing
3312	Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process control equipment	33422	Radio & television broadcasting
3313	Manufacture of industrial process control equipment	33431	Audio and visual equipment manufacturing
5150	Wholesale of machinery, equipment and supplies	33451	Navigation, measuring and control instruments manufacturing
6420	Telecommunications	41731	Computer, computer peripheral & pre-packaged software wholesalers-distributors
7123	Renting office machinery and equipment (including computers)	41732	Electronic components, navigational & communications equipment & supplies, wholesalers-distributors
7200	Computer and related activities	41791	Office & store machinery & equipment wholesale-distributors
		51322	Cable and other program distribution
		51331	Wired telecommunications carriers
		51332	Wireless telecommunications carriers (except satellite)
		51334	Satellite telecommunications
		51339	Other telecommunications
		53242	Office machinery & equipment rental & leasing
		51121	Software publishers
		51419	Other information services
		51421	Data processing
		54151	Computer systems design & related services
		81121	Electronic & precision equipment repair & maintenance

Source: April, 1999: 7 (Statistics Canada)

Appendix B, Chart 5, ICT industries included in the ICT Definition

International Standard Industry Classification	Australian and New Zealand Standard Industry Classification	North American Industry Classification System
3000 Office, accounting and computer machinery Manufacturing	2841 Computer and Business Machine Manufacturing	33331 Commercial Machinery Manufacturing
3130 Insulated wire and cable Manufacturing	2852 Electric Cable and Wire Manufacturing	33592 Communication and energy wire and cable Manufacturing
3210 Electronic valves and tubes Manufacturing	2849 Electronic Equipment Manufacturing	33441 Semiconductor and other electronic component Manufacturing
3220 Television and radio transmitters Manufacturing	2842 Telecommunications broadcasting and transceiving equipment Manufacturing	33421 Telephone apparatus Manufacturing 33422 Radio and Television and Wireless Communications Equipment Manufacturing
3230 Television and radio receivers Manufacturing	2842 (as above)	33431 Audio and video equipment Manufacturing
3312 Instruments for measuring, testing and navigating Manufacturing	2839 Professional and Scientific Equipment Manufacturing	33451 Navigational, measuring, medical and controlling devices Manufacturing
3313 Industrial Processes equipment Manufacturing	2839 (as above)	33451 (as above)
5150 Wholesaling of machinery, equipment and supplies	4612 Professional Equip. Wholesale, 4613 Computer Wholesaling, 4614 Business Machine Wholesaling, 4615 Electrical Equip. Wholesaling	41731 Computer pre-packaged software wholesaler distributors, 41732 Electronic Components, Navigational and communications Equipment Suppliers, 41791 Office and store machinery
6420 Telecommunications services	7120 Telecommunications Services	51322 Cable program distribution, 51331 Wired Telecommunications, 51332 Wireless Telecommunications, 51333 Telecom. Resellers, 51334 Satellite Telecommunications, 51339 other telecommunications
7123 Renting of office machinery and equipment	7743 Plant Hiring or leasing	53242 office Machinery and equipment rental and leasing
72 Computer and related activities	7831 Data Processing Services, 7832 Info. Storage & Retrieval 7833 Computer Maintenance 7834 Computer Consultancy Services	51121 Software Publishers, 51419 Other Information Services, 51421 Data Processing Services, 54151, Computer Systems Design 81121 Electronic equipment repair and maintenance

Source: OECD, 2002

Appendix B, Chart 6
 Information Technology Producing Industries NAICS to SIC concordance, Cooke, 2002

Hardware Industries	1997 NAICS	1987 SIC
Computers and computer equipment, calculating and office machines	334111,2,3,9,3344419pt, 3571,2,5,7pt, 3578, 9pt, 333311pt, 3pt	3571,2,5,7pt, 3578, 9pt
Wholesale trade of computers	421430pt, 3pt	5045pt
Retail trade of computers	443120pt	5734pt
Electron tubes	34411	3671
Printed circuit boards	334412	3672
Semiconductors	334413	3674
Passive electronic components	334414, 5, 6, 8pt, 9	3675, 6, 7, 8, 9pt, 3661pt
Industrial Instruments for measurement	334514	3823
Instruments for measuring electricity	334514pt, 334515	3825pt
Laboratory analytical instruments	334516	3826
Software/Service Industries		
Computer programming services	541511	7371
Pre-packaged software	511210, 334611	7372
Wholesale trade of software	421430pt	5045pt
Retail trade of software	443120pt	5734pt

Computer integrated systems design	541512	7373
Computer processing, data preparation	514210	7374
Information retrieval services	514191, 9	7375
Computer services management	541513	7376
Computer renting and leasing	532420	7377
Computer maintenance and repair	811212	7378
Computer related services, nec	541519	7379
Communications Services Industries		
Telephone and telegraph communications	513310, 21, 22, 30, 40, 90	481, 4822, 4899
Cable and other pay TV services	513210, 20	4841
Communications Equipment Industries		
Household audio and video equipment	334310	3651, 3679pt
Telephone and telegraph equipment	334210, 334418pt	3661pt, 3577pt, 3679pt
Radio and TV communications equipment	334220, 334290	3663, 3679pt, 3699
Magnetic and optical recording media	334613	3695, 3577pt

Source: Cooke, 2002

Appendix B, Chart 7

Australia	
Computer Service Industries	
7831	Data Processing Service
7832	Information Storage and Retrieval Service
7833	Computer Maintenance Services
7834	Computer Consultancy Services
IT & T Specialist Industries	
2842	Telecommunications Broadcasting, Transceiving Equipment Manufacture
4613	Computer Wholesaling
7120	Telecommunications Services
7831	Data Processing Services
7832	Information Storage and Retrieval Services
7833	Computer Maintenance Services
7834	Computer Consultancy Services

(also included: any specialist businesses which derives 50% or more of their total income from IT&T goods and services.)

Source: *ABS Year Book Australia Special Article – The Information Society and Information Economy in Australia, 1999 ABS CAT NO:1301.1.01*

Appendix B, Chart 8

Table A.1. The OECD sector definition. Concordance table between ISIC rev. 3 and National Classifications

Classification ISIC rev. 3	European Union NACE rev. 1	Canada NAICS	United States US SIC	United States NAICS	Australia ANZSIC
30	30	33331, 33411	3571, 2, 5, 7pt, 8, 9pt	333313 334111, 334112, 334113, 334119	2841
3130	31.3	33592	3357	33592= (335921 + 335929)	2852
3210	32.1	33441	3671, 3672, 3674, 3675, 6, 7, 8, 9pt, 3661pt	334411, 334412, 334413, 334414, 334415, 334418, 334419	2849
3220	32.2	33421, 33422	3663, 3679pt, 3699, 3661pt, 3577pt, 3679pt	334220, 334290, 334210, 334418pt	2842
3312	33.2	33451	3825pt	334514pt, 334515	2839
3313	33.3	33451	3826	334516	2839
5150	51.43, 51.64, 51.65	41731, 41732, 41791	5045pt, 5045pt	421430	4612, 4613, 4614, 4615
6420	64.2	51322, 51331, 51332, 51333, 51334, 51339	481, 82, 89 4841	513310, 21, 22, 30, 40, 90 513210, 20	7120
7123	71.33	53242	7377	532420	7743pt
72	72	51121, 51419, 51421, 54151, 81121	7371, 7372, 7373, 7374, 7375, 7376, 7378, 7379	541511, 334611, 511210, 541512, 514210, 514191, 514199, 541513, 811212, 541519	7831, 7832, 7833, 7834

Source: OECD, 2002

Appendix B, Chart 9, Special Aggregation: Information and Communication Technology (ICT) Sector

Statistics Canada, Standards Division

TCT Sector is defined as a special aggregation of NAICS97 industries. based on ISIC rev.3 and converted to NAICS7 basis
 NAICS97 industries comprising the ICT sector:

333310	Commercial and service industry machinery manufacturing
334110	Computer and peripheral equipment manufacturing
334210	Telephone apparatus manufacturing
334220	Radio and television broadcasting and wireless communications equipment manufacturing
334310	Audio and video equipment manufacturing
334410	Semiconductor and other electronic component manufacturing
334511	Navigational, measuring, medical and control instruments manufacturing
334512	Measuring, medical and controlling devices manufacturing
335920	Communication and energy wire and cable manufacturing
417310	Computer, computer peripheral and pre-packaged software wholesaler-distributors
417320	Electronic components, navigational and communications equipment and supplies wholesaler-distributor
511210	Software publishers
513220	Cable and other program distribution
513310	Wired telecommunications carriers
513320	Wireless telecommunications carriers (except satellite)
513330	Telecommunications resellers
513340	Satellite telecommunications
513390	Other telecommunications
514191	On-line information services
514199	All other information services
514210	Data processing services
532420	Office machinery and equipment rental and leasing
541510	Computer systems design and related services
811210	Electronic and precision equipment repair and maintenance

Appendix B, Table 2
Canadian Industry Descriptions

Classification	Industry	Description	Description
NAICS	54151 Computer Systems Design and Related Services	This industry comprises establishments primarily engaged in providing expertise in the field of information technologies through one or more activities, such as writing, modifying, testing and supporting software to meet the needs of a particular customer, including the creation of Internet home pages; planning and designing computer systems that integrate hardware, software and communication technologies; on-site management and operation of clients' computer and data processing facilities; providing advice in the field of information technologies; and other professional and technical computer-related services	<p>*CAD/CAM systems services</p> <p>*CAE (Computer-aided engineering) systems services</p> <p>*Computer consulting services</p> <p>*Computer programming services, custom</p> <p>*Computer software programming services, custom</p> <p>*Facilities management services, computer</p> <p>*Internet page design services, custom</p> <p>*Local area network (LAN) systems integrators</p> <p>*Office automation, computer systems integration</p> <p>*Systems analysis and design, computer services (software)</p> <p>*Systems integration, computer</p>
SIC	7721 Computer Services	Establishments primarily engaged in providing computer facilities on a rental, leasing or time sharing basis and such activities as programming, planning and systems work.	<p>*computer consulting services</p> <p>*computer input preparation services</p> <p>*computer processing services</p> <p>*computer programming services</p> <p>*computer rental or leasing</p> <p>*computer services</p> <p>*computer software services</p> <p>*computer time-sharing services</p> <p>*software packages, computer services</p> <p>*systems analysis and design, computer services</p> <p>*systems design, computer service</p>

Source: Industry Canada, 2002c. *Information and Communications Technologies Statistical Overview, Industry Descriptions by NAICS, with product/services classifications and Industry Descriptions by SIC, with product/service classifications (URL: <http://strategis.ic.gc.ca/SSG/it00957e.html>)*

Appendix C, Table 1

Canadian ICT Services Industries, 1995-2001, Employment (ICT services)

Employment	1995	1996	1997	1998	1999	2000	2001
Cable & other program distribution	10500	9483	8971	9472	12197	14109	14700
Telecommunications Services	120486	112421	111582	113421	113595	115985	118589
Software & Computer Services (inc. Self-employed)	117919	132244	157677	180031	228300	254575	279700
Total ICT Services	248905	254148	278230	302924	354092	384669	412989
Software and Computer Services (SIC 772- Aggregation of NAICS 51121, 514191, 51421 & 54151)	117919	132244	157677	180031	228300	254575	279,700 (68,600 are self-employed)
Software Publishers (NAICS 51121)			21324	27676	35816	36943	n/a
On-Line Information Services (NAICS 514191)			5624	5695	6582	9288 (2,800 self-employed)	n/a
Data Processing Services (NAICS 51421)			8179	11282	10622	14452 (300 self-employed)	n/a
Computer Systems Design and Related Services (NAICS 54151)			122550	135378	175280	193892 (59,400 self-employed)	n/a
Cable and other program distribution (NAICS 51322)	10500	9483	8971	9472	12197	14109	14700
Telecommunications Services (NAICS 5133)	120486	112421	111582	113421	113595	115985	118589
ICT Wholesaling, 1995-2001	1995	1996	1997	1998	1999	2000	2001
Employees	40740	44982	47169	47982	51286	52901	55327
ICT Manufacturing 1995-2001	1995	1996	1997	1998	1999	2000	2001
Total Employees (Aggregate)	95024	93486	99634	104730	112160	121850	105600

Source: (adapted) Information and Communications Technologies Statistical Overview
Information and Communications Technologies branch, Spectrum, Information technologies and telecommunications sector, Industry Canada, Nov. 2002a

Appendix D, Table 1
Definitions of IT workers used in recent U.S. studies

Report Author	Date	Definition
Freeman & Aspray, Computing Research Association (US)	1999	There are four categories of IT workers, depending on the principal function in their occupation: conceptualizers (e.g. systems analyst, computer science researcher), developers (e.g. programmer, software engineer), modifiers/extenders (e.g. computer engineer, database administrator), and supporters/tenders (e.g. system consultant, network administrator)
Office of Technology Policy (US)	1999	The 'core' IT occupations are considered to be computer scientists (including database administrators, computer support specialists, and all other computer scientists), computer engineers, systems analysts, and computer programmers
Information Technology Association of America (ITAA)	2000	<p>Definition based on eight job clusters: program/software developer; enterprise information systems integration; database administrator/developer; interactive digital medium specialist; web administrator; technical writer; networks system specialist; computer systems support representative</p> <p>Any skilled worker who performs any function related to information technology, which itself defined as the 'study, design, development, implementation, support or management of computer-based information systems, particularly software applications and computer hardware</p>
Committee on Workforce Needs in Information Technology, Computer Science and Telecommunications Board (CSTB)	2001	IT workers are those who engaged primarily in the conception, design, development, adaptation, implementation, deployment, training, support, documentation, and management of information technology systems, components or applications

Source: Freeman & Aspray, 1999; Stager, 2001:7 (adapted)

Appendix D, Table 2

Split of IT practitioners between supply and user organizations
(Figures for all EU member states, as of early 2000, estimates rounded)

Occupations/Sectors	(employed by all) IT (supply) Companies (NACE 72)	(employed by all) IT User Organizations	Total employed by all employers
IT practitioner occupations (‘computing professionals’ and ‘computer associate professionals’)	1 021 000	1 422 000	2 443 000
(All) Other Occupations	936 000	155 022 000	155 958 000
Total of all Occupations	1 957 000	156 444 000	158 401 000

Source: (CEPIS, 2002: 35)

Appendix D, Chart 1
IT-related Jobs

Skill Level: High	Engineering Managers
	Computer and information systems managers
	Computer and information scientists, research
	Computer programmers
	Computer software engineers, applications
	Computer software engineers, systems software
	Computer support specialists
	Database administrators
	Network and computer systems administrators
	Network systems and data communications analysts
	Computer hardware engineers
	Electrical engineers
	Electronics engineers, except computer
	Electrical and electronic engineering technicians
Skill Level: Moderate	Data entry keyers
	Computer, Automated Teller Machine (ATM), and office machine repairers
	Telecommunications equipment installers and repairers, except line installers
	Electrical and electronics repairers, commercial and industrial equipment
	Electrical and electronic equipment assemblers
	Electromechanical equipment assemblers
	Semiconductor processors
Skill Level: Low	Switchboard operators, including answering service
	Telephone operators
	Billing and posting clerks and machine operators
	Computer operators
	Mail clerks and mail machine operators, except postal service
	Other office machine operators

Source: Cooke, 2002: 44 (Digital Economy, US)

Appendix D, Chart 2

International Standard Occupational Classification (ISCO) 'Core' IT or 'Computer Workers'

Computing Professionals (ISCO 213):

Conduct research, plan, develop and improve computer based information systems, software and related concepts, develop principles and operational methods as well as to maintain...systems...ensuring integrity and security of data. This includes computer systems designers and analysts, computer programmers and computer engineers.

Computer Associate Professionals (ISCO 312):

Provide assistance to users....control and operate computers and peripheral equipment and carry out limited programming tasks connected with the installation and maintenance of computer hardware and software. This includes photographers and image and sound recording equipment operators, broadcasting and telecommunications equipment operators.

Excluded from this definition: IT managers, computer operators, computer engineers, computer sales staff, IT workers in education, some IT staff in the defence industry, telecoms practitioners and electronics engineers.

Source: (OECD, 2002: 16; CEPIS, 2002: 35-37)

Appendix D, Table 3

Eurostat LFS Data

Member State	ISCO 213 Total 'Computing Professionals'	ISCO 312 Total 'Computer Associate Professionals'	ISCO 213 + 312 (total IT occupations)
Germany	295,500 (2000 Qtr. 2)	256,600 (2000 Qtr.2)	552100
Ireland	20,800 (2000 Qtr. 2)	No returns ¹	20800
Sweden	92,900 (2000 Qtr.2)	42,300 (2000 Qtr. 2)	135200
United Kingdom	540,800 (2000 Qtr.2)	No returns	540800

Source: (CEPIS, 2002:38)

¹In the U.K and Ireland, IT workers are grouped entirely in ISCO 213, therefore are no data for ISCO 312 from either member state.

Appendix D, Table 4

Germany's IT Workers

Year 2000	IT industry	Total: all industries
Computing Professionals (ISCO 213)	111 195	295 529
Computer Associate Professionals (ISCO 312)	97 945	256 558
Total IT Practitioners	209 140	552 087
Total All Occupations	388 566	36 324 000

Source: CEPIS, 2002:42

Appendix D, Chart 3

SOC Bureau of Labor Statistics (United States)

Descriptions of Information Technology Professionals

Computer Scientists:

Computer scientists generally design computers and conduct research to improve their design or use, and develop and adapt principles for applying computers to new uses. They are distinguished from other computer professionals by the higher level of theoretical expertise and innovation they apply to complex problems and the creation or application of new technology. Computer scientists employed by academic institutions work in areas ranging from theory, to hardware, to language design. Some work on multidisciplinary projects, such as developing and advancing uses for virtual reality. Computer scientists in private industry work in areas such as applying theory, developing specialized languages, or designing programming tools, knowledge-based systems, or computer games.

Computer Engineers:

Computer engineers work with the hardware and software aspects of systems design and development. Computer engineers may often work as part of a team that designs new computing devices or computer-related equipment. Software engineers design and develop both packaged and systems software.

Systems Analysts:

Systems Analysts (SAs) use their knowledge and skills in a problem solving capacity, implementing the means for computer technology to meet the individual needs of an organization. They study business, scientific, or engineering data processing problems and design new solutions using computers. This process may include planning and developing new computer systems or devising ways to apply existing systems to operations still completed manually or by some less efficient method. SAs may design entirely new systems, including both hardware and software, or add a single new software application to harness more of the computer's power. They work to help an organization realize the maximum benefit from its investment in equipment, personnel and business processes.

Computer Programmers:

Computer Programmers (CPs) write and maintain the detailed instructions, called "programs" or "software," that list in logical order the steps that computers must execute to perform their functions. In many large organizations, CPs follow descriptions prepared by SAs who have studied the task that the computer systems is going to perform. The transition from a mainframe to a primarily PC-based environment has blurred the once rigid distinction between the programmer and the user. Increasingly adept users are taking over many of the task previously performed by CPs. A growing number of sophisticated software packages allow users and SAs to write programs.

Source: Bureau of Labor Statistics, U.S. Department of Labor (reproduced from America's New Deficit: The Shortage of Information Technology Workers, Office of Technology Policy, Department of Commerce, 1998:6)

Appendix D, Chart 4

United Kingdom IT practitioner SOC categories used in the Labour Force Survey

Computer Systems (etc.) Managers (SOC 126):

Those who plan, organise, direct and co-ordinate the clerical, operative, and other work necessary to operate computer equipment and develop procedures and prepare programs for automatic data processing.

Related job titles cited are computer manager, computer operations manager, data processing manager, systems manager.

Software Engineers (SOC 214):

Software Engineers are responsible for all aspects of production and support of software for computer based systems.

Related job titles cited are project leader (computing), systems designer (computing).

Computer Analysts & Programmers (SOC 320):

Computer analyst/programmers identify areas in which management and business efficiency can be improved by computerised procedures, design, plan and implement computer systems and design, develop and test software needed to carry out specific tasks such as engineering design, accounts and personnel functions, business processes, etc.

Related job titles are analyst/programmer, applications programmer, computer analyst programmer, programmer analyst, systems analyst.

Computer (etc.) Operators (SOC 490):

Workers in this group operate accounting, calculating, keypunch, duplicating and addressing machines and data processing and computing equipment.

Related job titles cited are accounts machine operator, computer operator, data preparation operator, data processor, keypunch operator, key to disc operator.

Computer Engineers (SOC 526):

Computer Engineers, installation and maintenance workers, install, maintain and repair computer hardware.

Related job titles cited are computer maintenance engineer, computer service engineer, computer service technician

Source: reproduced from Dixon & Addison, (ITNTO) 2000

Appendix D, Chart 5

Information Technology High Skill Occupations used in Digital Economy, 2002 (U.S)

Occupation	Description of Duties
Engineering Managers	Plan, direct or coordinate activities in such fields as architecture and engineering or research and development in these fields
Computer and information systems managers	Plan, direct or coordinate activities in such fields as electronic data processing, information systems, systems analysis, and computer programming
Computer and information scientists, research	Conduct research into fundamental computer and information science as theorists, designers, or inventors. Solve or develop solutions to problems in the field of computer hardware and software
Computer programmers	Convert statements of problems and procedures to flow charts for coding into computer language. Develop and write programs to store, locate, and retrieve data and information. May program web sites
Computer software engineers, applications	Develop, create, and modify general computer applications software or specialized utility programs. Analyze user needs and develop software solutions. Design software or customize software for client use. May analyze and design databases within an application area.
Computer software engineers, systems software	Research, design, develop, and test operating systems-level software, compilers, and network distribution software for a variety of computing applications. (Medical, industrial, military, general) Set operational specifications and formulate and analyze software requirements.
Computer support specialists	Provide technical assistance to computer system users. Answer questions or resolve computer problems for clients in person or via telephone. May provide assistance in the use of computer hardware and software, including printing, installation, word processing, electronic mail, and operating systems.
Computer systems analysts	Analyze science, engineering, business, and all other data processing problems for application to electronic data processing systems. Analyze user requirements, procedures, and problems to automate or improve existing systems. May analyze or recommend commercially available software.
Database administrators	Coordinate, test and implement changes to computer databases using database management systems. May plan, coordinate, and implement security measures to safeguard computer databases.
Network and computer systems administrators	Install, configure, support, monitor and maintain an organization's local area network (LAN), wide area network (WAN), and internet system. May supervise network support and client server specialists and plan, coordinate, and implement network security measures.
Network systems and data communications analysts	Analyze, design, test, and evaluate network systems, such as local area networks (LAN), wide area networks (WAN), internet, intranet, and other data communications systems. Research and recommend network and data communications hardware and software. Include telecommunications specialists who deal with the interfacing of computer and communications equipment. May supervise computer programmers
Computer hardware engineers	Research, design, develop, and test computer or computer-related equipment for commercial, industrial, military, or scientific use. May supervise the manufacturing and installation of computer or computer-related equipment and components.
Electrical engineers	Design, develop, test, or supervise the manufacturing and installation of electrical equipment, components, or systems for commercial, industrial, military, or scientific use.
Electronics engineers, except computer	Research, design, develop, and test electronic components and systems for commercial, industrial, military, or scientific use. Design electronic circuits and components for use in fields such as telecommunications, aerospace guidance and propulsion control, acoustics, or instruments and controls.
Electrical and electronic engineering technicians	Apply electrical and electronic theory, usually under the direction of engineering staff, to design, build, repair, calibrate, and modify electrical components, circuitry, controls, and machinery for subsequent evaluation and use by engineering design staff.

Source: Cooke, 2002

Appendix D, Chart 6, Australian Bureau of Statistics: Highly Innovative Knowledge Based ICT occupations (ANSIC)

223	Computing Professionals	Computing Professionals design and prepare software to meet specific requirements in all aspects of the computing environment, and control and audit the operation of computing facilities within an organization.
2231-11	Systems Manager	Controls the operating effectiveness of IT systems, and arranges system maintenance and enhancements to meet the user requirements. Specializations: Database administrator, Network administrator.
2231-13	Systems Designer	Conducts research into computer and communications systems, and develops techniques for their effective application and use.
2231-15	Software Designer	Designs and modifies the operating environment software which links computer software and hardware. Specializations: Database Designer.
2231-17	Applications and Analyst Programmer	Writes, tests and maintains computer programs to meet the applications needs of end-users of computer systems.
2231-19	Systems Programmer	Writes, maintains and updates programs which control the overall functioning of computers. Specializations: Database Programmer (systems).
2231-21	Computer Systems Auditor	Designs and monitors control systems which ensure the integrity and security of data and reviews the organization's computing environment and usage of computer facilities. Specializations: Information Technology Security Manager
2231-79	Computing Professionals not elsewhere classified	Includes: Computer analysts, Computer scientists, Computer tester, Database analyst, Local area network controller.
1224-11	Information Technology Managers	Plans, administers and reviews the acquisition, development, maintenance and use of computer and telecommunications systems within an organization.
3294-11	Computing Support Technicians	Provides technical advice and support to users of computer software and hardware.

Source: ABS (2003) "Communications and Information Technology - The information technology and telecommunications (IT&T) sector," Year Book Australia, ABS CAT NO: 1301.0

Appendix D, Table 5
U.K IT worker estimates

	1999	2000	Scope
ISCO-88 213 Computing professionals, comprising: SOC90 214 software engineer + SOC90 320 Analysts & Programmers	482000	505000	Actual (core technical) in UK
SOC90 totals 126 Computer Systems Manager 214 Software Engineer 320 Analysts and Programmers 490 Computer Operators 526 Computer Engineers	870000	886000	Actual (all IT- related occupations) in UK
IDC EITO "ICT Skills" (Figures for 'Supply' of skills for:) Internetworking Applications Distributed Technology Neutral Host-based	1608000	1687000	IDC- Asserted for UK
SOC90 totals for all ITPs as percentage of IDC ICT Skill totals	54.1%	52.5%	

Source: (CEPIS, 2002: 108)

Appendix E, Table 1, SFIA skills framework

Category	Sub-category	Skill
Strategy and Planning	Information management	Information resource management
	Advice and Guidance	Consultancy, technical specialism
	Business/IS strategy and planning	Business process improvement, IS strategy and planning, business risk management
	Technical strategy and planning	Systems architecture, change control, business continuity planning, emerging technology monitoring, methods & tools, network planning
Management and Administration	Supply management	contract management, procurement
	Project management	Programme management, project management, project office
	Quality management	Quality assurance, Quality management, compliance
	Resource management	Asset management, Systems development management, IS co-ordination, ICT management, Service delivery management
Sales and marketing	Sales and marketing	Account management, Marketing, Selling, Sales Support
Development and Implementation	System development	Business analysis, Systems design, Database analysis, Programming/software development, Technical authority, Systems testing
	Human factors	Systems ergonomics, Media creation
	Installation and integration	Systems integration, systems installation/decommissioning
Service Delivery	Education and Training	Education & training management, Development & training, Education & training delivery, Training materials creation
	Infrastructure	Configuration management, Network control, Capacity management, Security administration
	Operation	Application & System support, ICT operations, Database administration, Service level control
	User support	Network administration & support, user support
User	User	Business-IS alignment, information handling, use of ICT

Source: NTO (2001:6)

Appendix E, Table 2, Combining NOC and OSPM Skills for IT occupations

Skill Types	Occupation Type	Occupations
0	Senior Management Occupations	0112 Human Resource Managers education/training management
		021 Managers in Engineering, Architecture, Science and Information Systems (was 0213 Information Systems and Data Processing Managers)
		611 Sales, Marketing and Advertising Managers 611.5 E-Commerce Managers
NOC Skill Type 2	Natural and Applied Sciences and related Occupations	213 Civil, Mechanical, Electrical and Chemical Engineers 2133 Electrical and Electronics Engineers
		214 Other Engineers 2147 Computer Engineers (except software engineers), Technical Architecture, Capacity and Performance
		217 Computer and Information Systems Professionals 2171.1 Information systems business analysts and consultants analysis design business analysis and service level management informatics consultancy problem management 2171.2 Systems security analysts security 2171.3 Information systems quality assurance analysts Quality Assurance 2171.4 Systems Auditors, Systems Audit
		2172 Database Analysts and Data Administrators 2172.1 Database Administrators Database Administration 2172.2 Database Administration Analysts, Data Administration
		2173 Software Engineers Software Design and Delivery
		2174 Computer Programmers and Interactive Media Developers 2174.1 Computer Programmers Programming Analysis Programming Systems Programming 2174.2 Interactive Media Developers
		2175 Web Designers and Developers
Skill Level B	Technical, Paraprofessional and Skilled Occupations	224 Technical Occupations in Electronics and Electrical Engineering 2241 Electrical and Electronics Engineering Technologists and Technicians
		228 Technical Occupations in Computer and Information Systems 2281 Computer and Network Operators and Web Technicians 2281.1 Computer and Network Operators Operations Routine Network Support 2281.2 Web Technicians
		2282 User Support Technicians IT Help Desk User/Technical Support
		2283 Systems Testing Technicians Testing
NOC Skill Type 5	Occupations in Art, Culture, Recreation and Sport	
Skill Level A	Professional	512 Writing, Translating and public relations professional 5121 Authors and writers 5121.2 Technical Writers Technical Writing

Source: Industry Canada, 2002d Defining Canadian Information Technology (IT) Occupations for Industry and Government.

Appendix E, Table 3

Defining Canadian Information Technology (IT) Occupations for Industry and Government

NOC 2001

Groupings of the 24 Job Streams		
1	Informatics Business, Informatics Consultancy, Informatics Management	Problem Management, Project Management
2	Informatics Data	Data Administration, Database Administration
3	Informatics Education	Education/Training, Technical Writing
4	Informatics Evaluation	Business Analysis and Service Level Management, Capacity and Performance, Technical Architecture
5	Informatics Integrity	Help Desk, Network Support, Quality Assurance, Security, Testing, User/Technical Support
6	Informatics Operations	Audit, Operations Routine, Systems Programming
7	Informatics Technical	Analysis Design, Analysis Programming, Programming, Software Design and Delivery (a.k.a. Engineering)

Source: (Industry Canada, 2002d. Defining Canadian Information Technology (IT) Occupations for Industry and Government, p. 10)

Appendix E, Table 4
21 IT Occupations

NOC Code	Occupation
0122	Human Resource Manager
0213	Computer and Information System Manager
06115	e-Commerce Manager
2133	Electrical and Electronics Engineer
2147	Computer Engineer (except software)
21711	Information Systems Business Analyst
21712	Systems Security Analyst
21713	Information Systems Quality Assurance Analyst
21714	Systems Auditor
21721	Database Administrator
21722	Database Administration Analyst
2173	Software Engineers
21741	Computer Programmer
21742	Interactive Media Developer
2175	Web Designers and Developer
22811	Computer and Network Operator
22812	Web Technician
2282	User Support Technician
2283	Systems Testing Technician
51212	Technical Writer
5241	Graphic Designer and Illustrator

Source: SHRC, 2001

Appendix E, Chart 1
National Survey of Information Technology Occupations, 2002
List of Occupations (based on NOC 2001)

Computer and Information Systems Managers:

Computer and information systems managers plan, organize, direct, control and evaluate the activities of organizations that analyse, design, develop, implement, operate and administer computer and telecommunications software, networks and information systems.

Information Technology (IT) Project Managers:

IT project Managers coordinate systems development for major applications; define project requirements including information data needs, business analysis and programming; and develop, plan, analyze, evaluate and assign priorities to deliverables and requirements. Additionally, they define project phases, set deadlines and direct staff.

E-commerce Managers:

E-commerce managers plan, organize, direct, control and evaluate the design, development and maintenance of Internet and Intranet sites to manage an organization's Internet presence including public relations, communications and commercial activities.

Electrical and Electronics Engineers:

Electrical and electronics engineers design, plan, research, evaluate and test electrical and electronic equipment and systems.

Computer and Telecommunications Hardware Engineers:

Computer and telecommunications hardware engineers analyze user's requirements, and design and develop system architecture and specifications; research, design, develop and integrate computer and telecommunications hardware such as microprocessors, integrated circuit boards and semiconductor lasers; develop and conduct design verification simulations and prototype bench tests of components; supervise, inspect and provide design support during the manufacturing, installation and implementation of computer and telecommunications hardware; establish and maintain relationships with suppliers and clients.

Network Systems and Data Communication Engineers:

Network system and data communication engineers research, design and develop information and communication system network architecture; research, evaluate and integrate network system and data communication hardware and software; assess, document and optimize the capacity and performance of information and communication system networks.

Information Systems Business Analysts and Consultants:

Information systems business analysts and consultants confer with clients to identify and document requirements; conduct business and technical studies; design, develop and implement information systems business solutions; and provide advice on information systems strategy, policy, management and service delivery.

Systems Security Analysts:

Systems security analysts assess physical and technical security risks to data, software and hardware; and develop policies, procedures and contingency plans to minimize the effects of security breaches.

Information Systems Quality Assurance Analysts:

Information systems quality assurance analysts develop and implement policies and procedures throughout the software development, life cycle to maximize the efficiency, effectiveness and overall quality of software products and information systems.

Systems Auditors:

Systems auditors conduct independent third-party reviews to assess quality assurance practices, software products and information systems.

Database Analysts:

Database analysts design, develop and administer data management solutions using database management software. Database analysts perform some or all of the following duties: collect and document user's requirements; design and develop database architecture for information systems projects; design, construct, modify, implement and test data models and database management systems; conduct research and provide advice to other informatics professionals regarding the selection, application and implementation of database management tools; operate database management systems to analyse data.

Data Administrators:

Data administrators develop and implement data administration policy, standards and models; research and document data requirements, data collection and administration policy, and data access rules; develop policies and procedures for network access and usage and for the backup and recovery of data; conduct research and provide advice to other information systems professionals regarding the collection, availability and suitability of data.

Software Engineers:

Software engineers research, design, evaluate, integrate and maintain software applications, technical environments, operating systems, embedded software, information warehouses, and telecommunications software

Computer Programmers:

Computer programmers write, modify, integrate and test computer code for microcomputer and mainframe software applications, data processing applications, operating systems-level software and communications software.

Interactive Media Developers:

Interactive media developers write, modify, integrate and test computer code for internet applications, computer-based training software, computer games, film, video and other interactive media.

Web Designers and Developers:

Web designers and developers research, design, develop and produce internet and intranet sites; consult with clients to develop and document web site requirements; prepare mock-ups and storyboards; develop web site architecture and determine hardware and software requirements; source, select and organize information for inclusion and design the appearance, layout and flow of the web site; create and optimize content for web site using a variety of graphics, database, animation and other software; research and evaluate a variety of interactive media software products.

Electrical and Electronics Engineering Technologists and Technicians:

Electrical and electronics engineering technologists and technicians may work independently or provide technical support and services in the design, development, testing, production and operation of electrical and electronic equipment and systems.

Computer and Network Operators:

Computer and network operators establish, operate, maintain, and co-ordinate the use of local and wide area networks (LANS and WANs), mainframe networks, hardware, software and related computer equipment

Web Technicians:

Web technicians set up and maintain internet and intranet web sites and web server hardware and software, and monitor and optimize network connectivity and performance.

User Support Technicians:

User support technicians provide first-line technical support to computer users experiencing difficulties with computer hardware and with computer applications and communications software.

Systems Testing Technicians:

Systems testing technicians execute test plans to evaluate the performance of software applications and information and telecommunications systems.

Information Technology (IT) Trainers:

IT trainers teach, train and instruct at all levels to include any aspects of expertise within the scope of informatics (systems development, support and operations, technical skills)

Technical Writers:

Technical writers analyze material, such as specifications, notes and drawings, and write materials, user guides and other documents to explain clearly and concisely the installation, operation and maintenance of software and electronic, mechanical and other equipment.

Graphic Designers:

Graphic designers conceptualize and produce graphic art and visual materials to effectively communicate information for publications, advertising, films, packaging, posters, signs and interactive media such as web sites and CD-ROMs.

Illustrators:

Illustrators conceptualize and create illustrations to represent information through images.

Source: Statistics Canada, 2002

Appendix E, Table 5
 Analysis of the LFS data for the IT occupations
 2000-2002, Occupational Groupings

Group	NOC	Occupation
Managers	213	Computer and Information Systems Manager
	6115	e-Commerce Manager
Engineers	2133	Electrical and Electronics Engineers
	2147	Computer Engineers (excluding Software)
	2173	Software Engineers
Analysts	21711	Information Systems Business Analysts
	21712	Systems Security Analysts
	21713	Information Systems Quality Assurance Analysts
	21721	Database Administrators
	21722	Database Administration Analysts
Programmers	21741	Computers Programmers
	21742	Interactive Media Developers
	2175	Web Design Developers
Technicians	22812	Computer Network Technicians
	22812	Web Technicians
	2282	User Support Technicians
	2283	Systems Testing Technicians

Source: Wolfson, 2002

Appendix E, Table 6
Employment in IT in July 2001 (based on 18 NOC IT occupations)

213	Computer and Information Systems Manager	21,700
2133	Electrical and Electronics Engineers	29,300
2147	Computer Engineers (excluding Software)	11,200
2173	Software Engineers	21,600
21711	Information Systems Business Analysts and Consultants	75,900
21712	Systems Security Analysts	3,300
21713	Information Systems Quality Assurance Analysts	4,100
21721	Database Administrators	4,000
21722	Database Administration Analysts	2,300
21741	Computer Programmers	123,100
21742	Interactive Media Developers	6,000
2175	Web Designers and Developers	8,500
22811	Computer and Network Operators	49,000
22812	Web Technicians	5,100
2282	User Support Technicians	35,500
2283	Systems Testing Technicians	5,900
5241	Graphic Designers and Illustrating Artists	80,800
51212	Technical Writers	5,100

Source: Software Human Resource Council, Human Resources Development Canada, 2001