Chapter 4

Firm Demographics in Silicon Valley North

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Abstract

Based on Ottawa Centre for Research and Innovation (OCRI) database, this chapter analyzes clusters of firms in Silicon Valley North (SVN) and compares them with other clusters in other Silicon areas like Oxfordshire, England, and Silicon Valley, USA. Specifically, the purpose of the chapter is to present some demographics data on firms in Silicon Valley North. Firms are divided into five clusters: telecommunications, photonics, microelectronics, software, and life sciences.

1. Introduction

Innovation is a key factor in the economic development of regions and countries. Reich (1991, 2003) insists on the competitive pressure for continuous innovation. The Government of Canada (2001, 2002) acknowledges the importance of innovation in the information-economy era and has developed an innovation strategy to attempt to reach a new level of innovation in this country.

Papadopoulos (1997) recognized the shift from a "local" economic development perspective to a "world city" point of view, where cities across the globe compete against each other to develop and prosper. A world city may be a "technology centre" if the city has a strong presence in the technologically intensive sectors of the knowledge-based economy. A quality economic foundation is also a must. The economic foundations consist of: the human resources, technology, financial capital, physical infrastructure, business climate and quality of life in a region (ICF Consulting 2000).

In a study for the City of Ottawa, ICF Consulting (2003b) proposes a framework for strategic decision making with respect to innovation for the City and the various stakeholders in the regions clusters. The innovation system could be divided into three strategic challenges: (1) the discovery of new knowledge by harnessing basic and applied science assets; (2) the development of that knowledge into new products and services by promoting

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a commercialization culture; and (3) the deployment of those products and services through new or expanded businesses by accelerating incubation and enabling the maturation and survival of firms.

Because of Ottawa's status as the nation's capital and the resulting concentration of national research centres, Ottawa's technology institutions are considered strong (ICF Consulting 2003a). We add to this the existence of two research-intensive universities and provincial research centres and programs. However, some problems are seen regarding the size of firms in Ottawa. To address these problems, Silicon Valley North (SVN) has created the Ottawa-Gatineau Commercialization Task Force (CTF) (Re$earch Money 2003). The objective of the CTF is to examine the apparent inability of Silicon Valley North firms to develop past the $5 million in annual sales level.

The CTF includes representatives from a variety of organizations such as the Canadian Advanced Technology Alliance, the City of Ottawa, the City of Gatineau, the Greater Ottawa Chamber of Commerce, the National Capital Institute of Telecommunications, the National Research Council, OrbitIQ, the Ottawa Centre for Research and Innovation, the Ottawa Life Sciences Council, The Ottawa Partnership, and representatives from the business schools and engineering faculties of both Carleton University and the University of Ottawa.

To help the CTF in this task of validating the anecdotal evidence that many of the members had contributed on the possible lack of commercialization in the region, a research team from both the local business schools (Carleton University's Eric Sprott School of Business and University of Ottawa's School of Management) was created. The first two phases of our research were: (1) to look at the distribution of firms based on size in the region; and (2) to compare Silicon Valley North to other technology regions. This study is a result of the collaboration between the two schools on behalf of the CTF.

The purpose of this chapter is to present some demographics data and analysis on firms in Silicon Valley North (SVN). Our research here focuses on five technologically intensive clusters (telecommunications, photonics, microelectronics, software, life sciences) paralleling previous studies of the broader technology sector in the city.

This chapter is organized as follows: first, this introduction has briefly presented some of the important contextual elements of the study. Then, Section 2 provides information regarding data used and definition of clusters. Section 3 presents data for the region as a whole and discusses each cluster. Section 4 compares Silicon Valley North data with other technology centers in the world. Finally, some concluding remarks are presented in Section 5.

2. Methodology and Data

2.1. Description of the OCRI Database

The Ottawa Centre for Research and Innovation (OCRI) is a partnership organization. The mission of OCRI is to be "the rallying point for business, education and government to advance Ottawa's globally competitive knowledge-based economy. With and through its members and partners, OCRI brings people, ideas and resources together — through connectivity — to build wealth and quality of life in Ottawa" (OCRI 2003; see also the chapters by Ghent Mallett and by O'Sullivan this volume).

As part of its mission, OCRI has developed and managed a database of technology firms in the Ottawa area. The database provides up-to-date listings of both public organizations and private firms in Ottawa's technology sector. The database is shared with the City of Ottawa (Ottawa Region 2003) and with the Ottawa Business Journal (2003). OCRI and the Ottawa Business Journal publish, on an annual basis The Ottawa Technology Industry Guide based on the information in this database. The data used in this study comes from the OCRI database updated as of June 2003.

2.2. Definition of Clusters

Silicon Valley North is a global technology centre, having strengths in a number of sectors. We have investigated five technologically intensive clusters in this study including: telecommunications, photonics, microelectronics, software, and life sciences (ICF Consulting 2000). In addition to these technology-intensive sectors, Silicon Valley North firms are supported by a strong professional services cluster. As Canada's capital, Ottawa has a dynamic tourism sector and is the seat of the federal parliament. The federal government, as a result, is the largest local employer with more than 92,000 employees in mid-2002 working in a variety of departments, agencies and institutions.

The telecommunications cluster in this study is defined as those firms engaged in, or linked to, the production of telecommunications equipment. It includes networking equipment, transmission systems, satellite/microwave equipment, communication interface devices, and similar technologies (ICF Consulting 2000). The telecommunications cluster has a strong research & development (R&D) emphasis and covers a wide range of technical activities from the assembly of basic telephone handsets to highly sophisticated digital switches.

Photonics could be defined as the field of science and engineering encompassing the physical phenomena and technologies associated with the generation, transmission, manipulation, detection, and utilization of light (OPC 2003). The photonics cluster includes an array of technologies related to the commercial application of light, including fibre optics, lasers, and optoelectronics, imaging, optical processing of information, and related applications (ICF Consulting 2000).

The microelectronics industry can be divided between semiconductor and electronic component design, system design, component manufacturing, component testing and design tools (CMC 2003). Ottawa's microelectronics cluster includes firms in all those industry groupings.

The software industry can be defined as an industry where firms primarily develop, sell, or support software products/systems, and Internet products/systems. Ottawa's software cluster encompasses an array of packaged software, software and information technology (IT) services, communications, Internet security, and remote sensing.

The life sciences industry can be divided between biotechnology, medical devices, pharmaceuticals, telehealth, health industries and health services. Ottawa's Life sciences cluster includes medical devices, biotechnology, stem cells research, medical diagnostic equipment, therapeutic equipment, implants/prostheses, and a range of electromedical applications (ICF Consulting 2000; OLSC 2003).

2.3. Challenges of the OCRI data

The OCRI database poses some challenges for the researchers. First, it is important to note that the purpose of the database is not academic research. An example of the challenges here includes the existence of incomplete data for some firms. Even if the objective of the researchers is to look at the distribution of firms based on size in the region, the database includes only the number of employees and the number of local employees. There are a very limited number of firms with revenue information. Secondly, it is up to the firms being surveyed to self-identify themselves for inclusion in one or more clusters. No specific or technical definition of the clusters is presented during the telephone interviews used to collect the data. Therefore, some firms are identified in multiple clusters (this is especially true for the largest firms in the region). This means that the data that is presented below for each of the individual clusters must be viewed in the context of the whole region. Totalling the number of firms identified within each of the clusters will result in double counting as some firms have identified themselves within multiple clusters. Finally, the data is updated on an on-going basis; hence there are no historical figures to compare to.

3. Silicon Valley North: History and Present Context

3.1. Canadian Silicon Valley: A High-Tech Region in the Making

The early development of Ottawa, or Bytown as it was known in the early 1800's, was related to the timber trade and large milling operations. Selected as capital of the Province of Canada in 1857 and capital of the Dominion of Canada in 1867, its dominant economic activity evolved from the timber trade and saw milling roots in the early 1800s, into pulp and paper which were the dominant industry in the early 1900s, to public services. The federal government of Canada became the dominant employer around 1940 (The Canadian Encyclopaedia 1988: 1595). In 1970, the Ottawa metropolitan area[1] had a population of slightly over 500,000 inhabitants and 33% of its workforce worked for the federal government. Since that time, population in the area has more than doubled to about 1,100,000 inhabitants, and in 2002 18% of the workforce (78,000 persons) was working for the federal government. High-Tech employment grew rapidly over the past 25 years, from 8,200 jobs in 160 firms in 1975, to a peak of 79,000 jobs in 1,300 firms 2000. Since that time, total employment in the sector is down slightly to about 70,000 jobs, based on a wide measure of employment generated by OCRI, albeit in 1,400 firms in early 2003. In 30 years, the local culture has changed from that of a sedate government town to that of an entrepreneurial and dynamic growth-oriented region. The main sectors of technology activity include telecommunications and microelectronics (40% of local high-tech jobs in 1999, a much lower percentage in 2002), software products (20% in 1999), software services, photonics, life sciences, and defence/aerospace. Ottawa has a well-educated labour force

[1] The "Ottawa" metropolitan area includes the city of Ottawa (currently about 800,000 inhabitants, in the province of Ontario) and of Gatineau (300,000 inhabitants, in the province of Quebec; see also the chapter by Materazzi this volume).

(28.1% of the population 20 years and older have a bachelor's degree or higher university degree, the highest in Canada, with Toronto at 24.9% and Calgary at 23.1%, ranking second and third respectively; Statistics Canada 2001), and a relatively wealthy population. The average annual household income in Ottawa was $62,800 with "very wealthy households" totalling 10.9%, compared to $68,400 and 14.8% respectively for Toronto, Canada's wealthiest metropolitan area in 2001 (FP Markets, Canadian Demographics 2001; Financial Post Publications 2001).

The development of Ottawa as a technology pole can be attributed to its solid research base and the existence of one large anchor private sector firm: large federal research laboratories such as the National Research Council (NRC, created in 1916), the Communication Research Center (CRC, created in late 1940s), and a very large private research laboratory, Bell Northern Research (the research arm of Northern Telecom, now Nortel), which was developed in Ottawa in 1960 to be close to the CRC. The failure of a small subsidiary of Northern Telecom in 1971 (Microsystems International) led a few local engineers to create several high-tech start-ups which did exceptionally well, and became role models for other would be entrepreneurs (see the chapter by Ghent Mallett this volume). They started the development of what was to become a very active entrepreneurial region. The creation, in 1983, of the Ottawa-Carleton Research Institute, a pro-active consortium of business, government and universities with the objective of developing business-university linkages, contributed significantly to the evolution of the region into a significant technology pole. Starting in the mid-1980s and accelerating in the 1990s, the sale of several successful start-ups created many instant millionaires who became active angel investors and led to the development of a very active venture capital industry (see also the chapter by Madill *et al.* this volume). Venture capital investment in the region peaked at $1.2 billion in 2000 (over a third of all venture capital investments in Canada) and has retreated to about $600 million annually since (see also the chapter by Callahan *et al.* this volume).

The region has often been described as a "home grown" technology pole. Until the mid-1990s, most technology enterprises were local start-ups. Only in the mid to late 1990s did multinationals create subsidiaries in Ottawa and foreign investors started to invest locally. For many years, new firm creation in telecommunications, microelectronics, software and photonics, occurred with no formal public technology incubation infrastructure and no direct university support. The region acted as a giant virtual incubator, with independent entrepreneurs finding advice and support through local networks and with former employees of the largest private firms (Nortel & Newbridge, for example) creating record numbers of spin-offs. In the mid-1990s, CRC opened a technology incubator and NRC started to provide advice to its own scientists on commercialization issues to spin-off firms, later followed by the opening of a technology incubator (Industry Partnership Facility). And more recently (2000), InnoCentre, an independent non-profit incubator, opened an office in Ottawa. To encourage the development of a life science sector to commercialize the research done in the field at both the NRC and at the University of Ottawa, the Provincial government created, in 1992, a provincially supported science park. The Ottawa Life Sciences Council, a not-for-profit consortium involving the government, local public organizations, private firms, the University of Ottawa, and the City of Ottawa manage this park. It was hoped that the park would attract more research organizations and private firms in the domain. Ten years later, that new "life science cluster" is slowly

starting to emerge, with a second multi-tenant building being built in the science park and two biotechnology incubators having just been completed in 2001.

Until the mid 1980s, the two local universities were less than pro-active in supporting the technology development of the region except as suppliers to a well trained labour force. Through OCRI and other partnerships with the private sector, and through their own research activities including their own spin-offs, they have now become pro-active partners in that development (Doutriaux 2003; see also the chapter by Armit this volume).

Local telecom activities have been hard-hit by the industry meltdown that occurred in later part of 2000. Local entrepreneurial spirit is still very high with a very high rate of creation of new technology firms in telecom, photonics, software, and life sciences. Three major challenges for Ottawa at this time are: (1) a paucity of top managerial talent and leadership to grow local firms to world class status; (2) insufficient knowledge and skills in technology marketing and sales to develop and grow new markets; and (3) encouraging local telecom-minded angel investors and venture capital firms to invest in life sciences start-ups, a sector which is expected to lead the next technology cycle (profiting in many cases from the convergence of telecom-photonics and life sciences).

It may be helpful to break the development of Ottawa's Technology region into a chronological series of stages. We have chosen to divide this between six periods/ stages that distinguish Ottawa's path to development. Only in stage three we do we see the emergence of specific actions designed to support the development of a technology cluster.

3.1.1. Stage one A high level of government R&D and government procurements led to an environment conducive to research and innovation, technology commercialization and high-tech start-ups. This occurred through: (1) unsolicited proposals for applied research and development; (2) subcontracts with the government; and (3) access to government procurements (one of the most important success factor for Canadian start-ups in the 1970s — early 1980s; Doutriaux 1991). Creating a company during this stage was also relatively simple (few regulations, easy incorporation), even in the absence of local investment capital (see also the chapter by Madill *et al.* this volume).

3.1.2. Stage two This stage is distinguished by the growth of BNR/Northern Telecom/Nortel, a large research and manufacturing telecommunications company, which developed its research laboratories in Ottawa to be close to government and its research laboratories and acted as a large private sector anchor organization, making the region more attractive to other private-sector ventures.

3.1.3. Stage three This period is characterized by:

- slow growth of the local telecommunication, microelectronics, and software sectors;
- "home-grown" start-ups follow the steps of solid local role models such as Mitel and Mosaid;
- creation of OCRI, a private sector-universities-government consortium intent on developing successful business-university-government partnerships, and creating occasions

for active networking activities (Monthly Technology Executive Breakfasts, monthly Zone 5 meetings (technology marketing), etc);
- development of better communication links (direct flights to major U.S. cities),
- development of high-tech support services (precision machining, precision mouldings, and so on); and
- growth of angel networks (wealthy local entrepreneurs).

3.1.4. Stage four This period is marked by:

- international recognition and high regional growth for Ottawa;
- development of local venture capital (VC);
- entry of U.S. VC following the highly visible purchases of local start-ups by large multinationals;
- some very successful IPOs;
- arrival in the region of external firms such as Cisco, Compaq, and Nokia.

3.1.5. Stage five This period is distinguished by:

- second generation VCs;
- wealthy entrepreneurs start nurturing local firms;
- creation of public and private incubators;
- high rate of start-ups;
- growing interest for medical and health sciences (partnership of universities, NRC, and hospitals).

3.1.6. Stage six (post 2000) This period is characterized by:

- relative regional slowdown with large layoffs by the largest corporations;
- high rate of start-ups by laid-off employees;
- drop in VC investment; creation of biotech incubators; and
- health sciences and biotechnology are considered as the next technology wave.

3.2. Ottawa's Technology Firms

The largest high-technology firms currently active in SVN are listed in Table 1. In addition, the *Ottawa Business Journal* has identified 46 public firms as local firms. These stocks are traded on the Toronto Stock Exchange (TSX), the TSX Venture Exchange (TSXV), the New York Stock Exchange (NYSE), and the NASDAQ. They are listed in Table 2.

The distribution by size (number of local employees) of all high-tech firms in the region listed in the OCRI database is given in Figure 1. That distribution shows that high-tech firms in the region are predominantly small, only 33 of 1,043 firms having more than 250 local employees. We will now consider the individual technology sectors (Figure 2).

Table 1: Major players in Ottawa by cluster(s).

	Number of Local Employees	Clusters				
		TE	PH	MI	SO	LS
Nortel Networks	6,000	x	x	x		
Alcatel Canada	2,000	x	x	x		
Mitel Networks	1,500	x				
Cognos Inc.	1,300				x	
Anjura Technology Corporation	950				x	
JDS Uniphase Corporation	860		x	x		
General Dynamics Canada	815	x				
MDS Nordion	800			x		x
IBM Canada Limited	700			x		
Corel Corporation	540				x	
Zomax Canada Company	526				x	
i-STAT Canada Ltd	520					x
Canadian Bank Note Company Limited	500				x	
BreconRidge Manufacturing Solutions	400	x		x		
Cisco Systems	400		x			
CRC — Communications Research Centre	400	x				
X-Wave	350	x			x	
DEW Engineering and Development Limited	300				x	x
Zarlink Semiconductor	300			x		

Note: TE = Telecommunications; PH = Photonics; MI = Microelectronics; SO = Software; LS = Life sciences.
Source: OCRI database.

3.3. Telecommunications

Understanding what the telecommunications industry was, what it is presently, and what it is going to be both with respect to products, customers, and industrial structure, is not easy. It is equally difficult to appreciate the rate of changes that have taken place over recent years. From a situation not long ago where firms were predominantly state protected monopolies and where services changed at a fairly slow speed we have now witnessed fundamental changes take place for telecommunications firms (for both operators or carriers, as they are most often called, and manufacturers). The kinds of services that firms provide to customers and the delivery channels that are available for those services (i.e. land-line vs. wireless) have been altered, as the result of radical technological developments (i.e. the movement to optical systems).

Speciality manufacturing firms were the first to change, around the 1970s, the result of the manufacturing and carrier businesses being separated from each other and the

Table 2: Publicly traded firms in Ottawa.

3M	JDS Uniphase
Adherex Technologies	Linmor
Adobe Systems	MDS
Alcatel Canada	MetaSolv
Avalon Works	Monolithic Systems
BCE	Mosaid Technologies
Beaufield Consolidated Res.	Nortel Networks
Calian Technology	Nuvo Network Management
Canadian Bank Note	O&Y Properties
C-Com Satellite Systems	Orezone Resources
CGI Group	Patrician Diamonds
Cisco Group	PharmaGap
Cognos	Phoenix Matachewan Mines
Electronic Data Systems	Plaintree Systems
EMS Technologies	PMC-Sierra
Entrust Technologies	Prospectus Group
Environmental Management Sol.	Seprotech Systems
Gennum Corp.	Solectron Corp.
GSI Lumonics	Thermal Energy
InBusiness Solutions	Tundra Semiconductor
International Datacasting	Workstream
In-Touch Survey	World Heart
I-STAT	Zarlink Semiconductor

willingness of governments to allow international competition for the specialized products that they sold. Telecommunication carriers were far slower to change as regulations continued to protect their regional markets from competition.

The movement towards deregulation, especially in Europe, and the creation of the Internet fundamentally altered the telecommunications industry. The potential of the Internet can still only be imagined, and yet it has already changed the nature of modern day work and life. For the industry, it represented a sales opportunity of epic proportions. While the initial timelines predicted for Internet traffic growth did not prove to be correct, the question of what the ultimate potential for the communications and computing medium could be remains an important motivator for firms and individuals alike. To reflect this motivating force, we now consider an Information and Communications Industry as a whole rather than telecommunications industry as a separate industry.

Ottawa has a rich tradition in the speciality manufacturing sector of the telecommunications industry. This industrial strength is the legacy of Northern Electric's decision in the late 1950s to locate substantial research facilities in the region, which was in part made because of the existing research strength of the city at that time (see also the chapter by Ghent Mallett this volume). This is also the result of research into communications technologies that

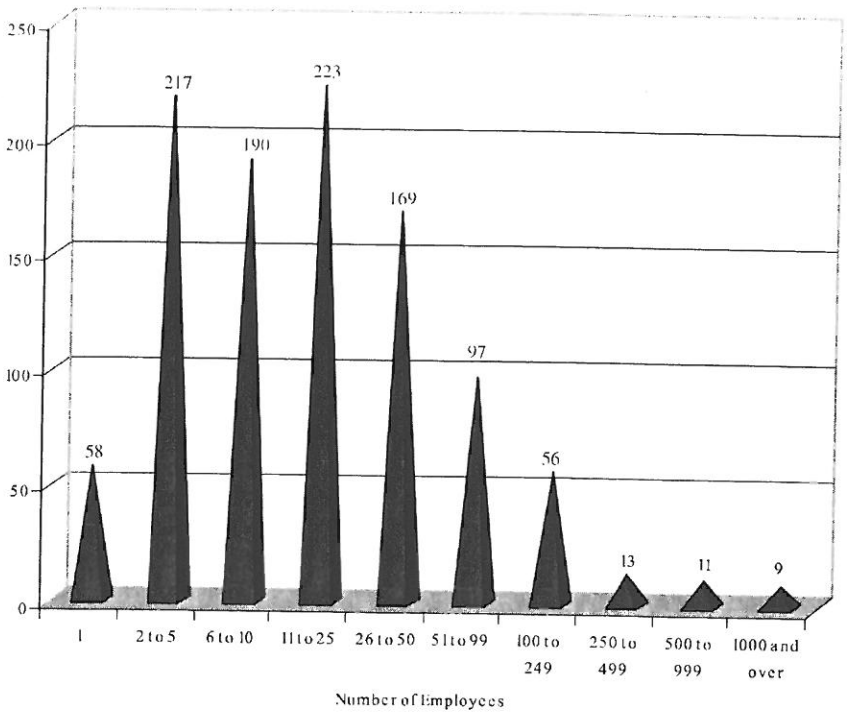

Figure 1: Distribution all high-technology firms in Ottawa (1043).

took place in Ottawa's dating back to the wartime efforts of the National Research Council (see also the chapter by Coll this volume). It was this sector that led the development of Ottawa's technological clusters. The explosive growth of Nortel and JDS Uniphase brought international attention to the region in the late 1990s. Nortel became the largest telecommunications firm in the world, while JDS Uniphase became a billion dollar (in sales) firm in record time.

The new millennium quickly brought with it major changes for the industry as a whole. Carriers, who had invested heavily in system upgrades to make the Internet a reality, became burdened with twin problems of heavy debt loads and excess capacity, both of which would come to hurt the specialty manufactures of the region. In 2000, it is estimated that internationally carriers spent $70 billion (U.S.). By 2003, this figure is estimated to have dropped to $20 billion (U.S.). The Ottawa-based telecommunications firms who counted international carriers as their most important customers did all they could to react to this almost unbelievable decline in customer sales, laying off thousands of workers and shutting down facilities as quickly as possible. Internationally, Nortel reduced its workforce by 60,000 with over 10,000 of those cuts taking place in Ottawa. This reduction was similar to those made internationally at Ericsson (54,000 world-wide) and Alcatel (60,000 world-wide), cuts that were very costly. The telecommunications industry in Ottawa is now fundamentally different than it was only three years ago. Total employment in all technological sectors

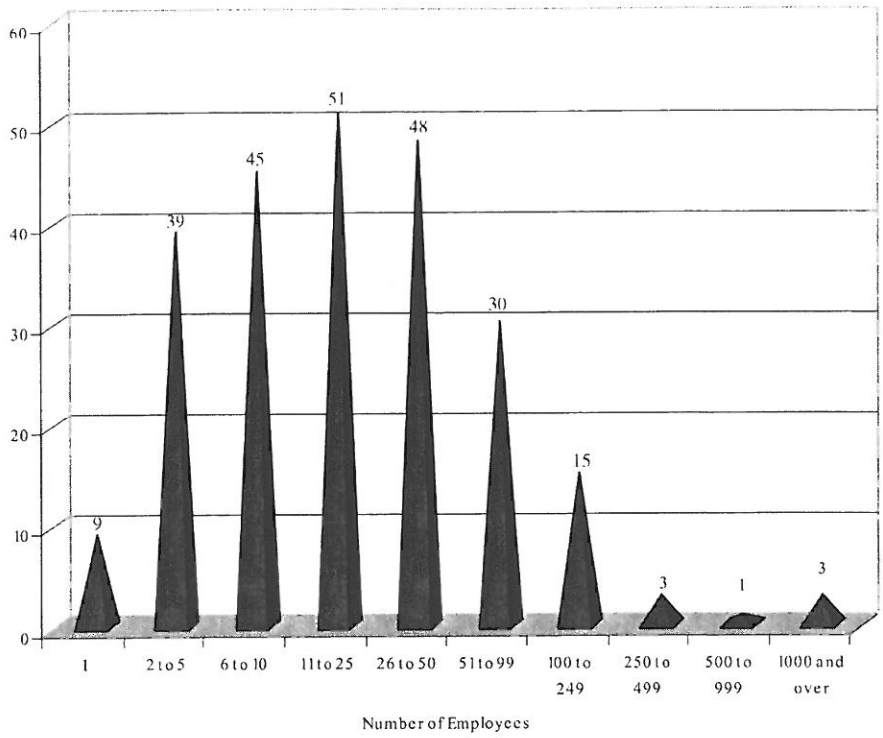

Figure 2: Distribution of telecommunications firms (total of 244 firms).

stands at approximately 51,000 in August of 2003, down by 18,000 jobs since its peak in March of 2001.

As Figure 1 has shown, Ottawa, as a technology region, is made up of mostly small firms, which is also the situation for the telecommunications sector in the region. On top of the dramatic declines in customer demands facing many of the telecommunications firms in the region, there has been an international redistribution of employment in the sector, with low-paying and relatively low-skilled manufacturing and assembly jobs being shifted from high-cost countries such as Canada and the United States to low labour cost regions such as South-East Asia (including China). JDS Uniphase, for example, has shifted almost all of it's manufacturing jobs that were previously located in Ottawa to Chinese facilities to save costs.

Even if we are to believe some of the more optimistic industry leaders, such as Ericsson CEO Carl-Henric Svanberg who has stated that "The industry is recovering" (BBC News 2003), the changes with respect to manufacturing are likely permanent and any future increases in employment in Ottawa's telecommunications sector will be dependent on the growth of highly-skilled and highly-paid jobs.

At the present time, we note that the number of firms with greater than 250 employees is only 7. These firms play an important role in the region as some of the only local customers of many of the smaller firms. Indeed, many of the smaller telecommunications firms are

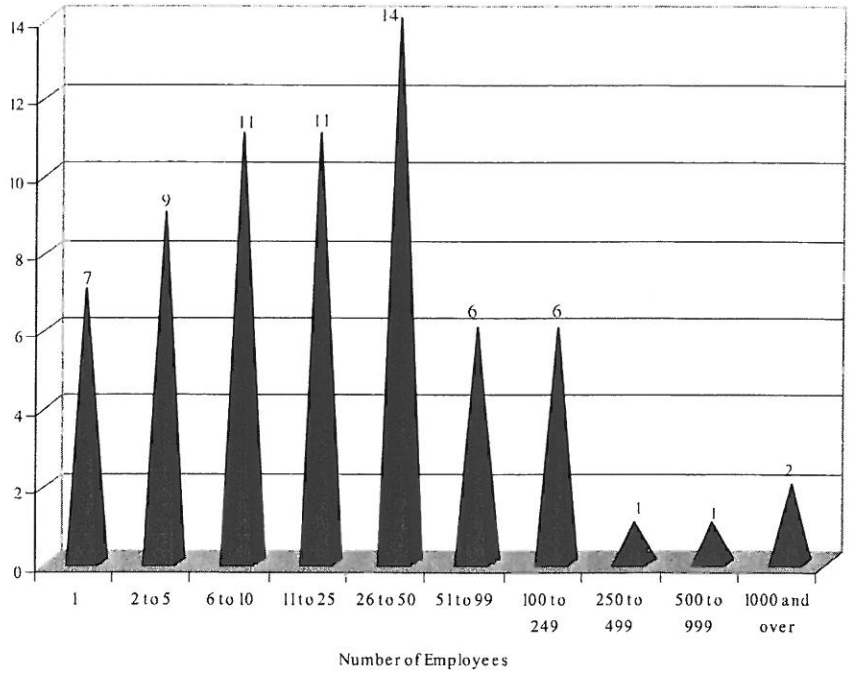

Figure 3: Distribution of photonics firms (total of 68 firms).

spin offs from the larger telecommunications firms, and some of the larger firms (Mitel, for example) are actually the result of previous rounds of downsizing and closures by Nortel (see also the chapter by Ghent Mallett this volume). There is therefore a symbiotic relationship between the large and small firms in Ottawa that was developed historically and we believe this will continue in the future. Stimulating the development of new firms, as well as the growth of existing medium-sized firms, is needed (Figure 2).

3.4. Photonics

The photonics sector, while presently the smallest sector in our study, is seen as containing great potential for future development (see Figure 3). However, this sector is not without its present challenges. First, it is important to comment that photonics is not presently a distinct sector so far as industrial classification systems are concerned. For example, there is no North American Standard Industrial Classification (NAICS) Code for photonics. The photonics sector in Ottawa has developed out of the telecommunications research and firms in the region, and the telecommunications industry continues to be important customer of photonics firms. The term "photonics," that is used to describe the sector, refers to technologies that are being utilized in the industry. As *The* Photonics Dictionary (2003) explains:

> Photonics is the technology of generating and harnessing light and other forms of radiant energy whose quantum unit is the photon. The science includes light emission, transmission, deflection, amplification and detection by optical components and instruments, lasers and other light sources, fibre optics, electro-optical instrumentation, related hardware and electronics, and sophisticated systems. The range of applications of photonics extends from energy generation to detection to communications and information processing.

Viewing the photonics sector from this technological standpoint illustrates the potential of the industry. The parallel could then be made between photonics and semiconductors (a sector where Ottawa also has strengths and which will be discussed in our section on microelectronics): whereas photonics applications in telecommunications are already in practice, the potential applications of this light-based technology are only beginning to be understood with respect to the bio-technology/bio-medical sector. Semiconductors have been one of the driving technologies of Silicon Valley for decades, and while the sector has had a number of very pronounced downturns, the ubiquity of chips (as they are commonly called) has meant that new product markets have continued to be found for the base semiconductor technology. It is suggested that photonics could be a similar type of technology as semiconductors with early indications being the foray of photonics firms into aviation and aerospace sectors.

At a regional level, the Ottawa-based photonics firms have benefited greatly from venture capital investments over the past many years. These investments, often totally over $10 million per company, per round, have provided the fuel necessary for the industry to grow. The largest firms in this sector are in fact the same as in the telecommunications sector, the result of their operations in both areas.[2]

Acknowledging the potential of the sector, we must note that the current photonics applications, which are presently available for sale, are predominately telecommunications based. Fibre-optics cables have been laid across land and under water at an incredible rate, however this "long-haul" capacity greatly exceeds present demands. As a result, the long-haul telecommunications products developed by the photonics sector are suffering from poor demand. Finishing the "last mile" or within metropolitan regions remains an important step, however what is more important for the firms within Ottawa is to develop new products for other sectors.

3.5. Microelectronics

The microelectronics sector in Ottawa is also intimately connected to the telecommunications sector at least historically. The largest firms in the sector (see Figure 4) such as Nortel Networks, Alcatel, and JDS Uniphase are also the largest telecommunications and

[2] This might result in a double counting problem when looking at these sectors individually, but we noted in Figure 1 (total employment for the region) that each firm is counted only once. For example, to deny that Nortel Networks, Alcatel, and JDS Uniphase are in the photonics industry would be to ignore the reality of cross-sectoral business and their contribution to the region within each sector.

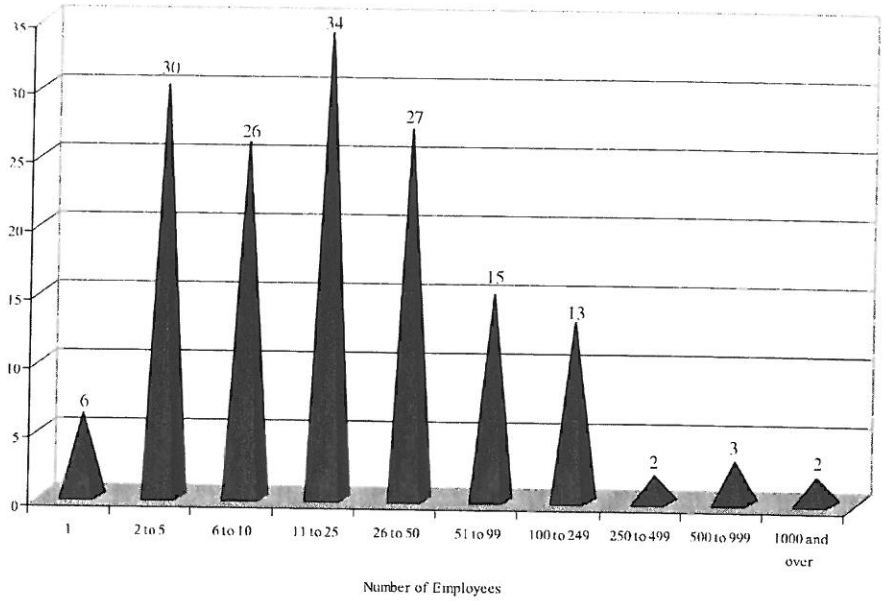

Figure 4: Distribution of microelectronics firms (total of 158 firms).

photonics firms. However, the firms that follow them (in terms of size) are an eclectic group of firms serving different sectors. MDS Nordion, for example, serves the health and life-sciences sector, while Dy-4 systems serves primarily the military and defences sectors, and IBM serves a variety of sectors including personal and industrial computing sectors.

Semiconductors, one of the product groups contained in this sector, have a particular international distribution of activities and significant employment. Ottawa-based semiconductor firms such, for example, as Tundra Semiconductors operate in a particular part of the industry, contributing design and development services to its customers. This places them in a high-valued position within the international semiconductor industry, where most employees are employed in highly paid research, design, and development positions. The largest semiconductor firms in the world, including Intel and Samsung, provide a full range of services and manufacturing. In order to be able to do this, they are required to build fabrication facilities that can cost in excess of $3 billion, which lose massive amounts of money if they are not kept at full capacity. Furthermore, the techniques for manufacturing the chips change periodically, the result of which has seen manufacturing move to Japan in the 1980s and then to other nations such as Singapore and perhaps with new manufacturing techniques, such as those used at IBM's East Fishkill facility in up-state New York, back to the United States. Competition in this part of the semiconductor industry is fierce and often influenced by government actions. As a result of these industrial realities, staying focused on niche markets may be optimal for firms in Ottawa. This does not, however, mean that they are unable to grow. Firms such as Tundra Semiconductors, Zarlink Semiconductors, and Dy-4 are excellent examples of what is possible. The market realities

may limit the possibilities of growing many purely microelectronics firms into very large firms (i.e. greater than 1000 employees).

3.6. Software

Software is Ottawa's largest sector by number of firms (see Figure 5). This is a sector where the city has a small number of star firms including Corel and Cognos. The former of these firms attempted, ambitiously, to compete directly with Microsoft Corporation, an attempt that has been widely criticized but must be seen as bold, especially in the context of Canadian firms. The latter of these two firms, Cognos, is regarded by some as Canada's most successful technology company. Their success has recently provoked the likes of Microsoft to consider moving into that specialized niche of the software industry where Cognos and Corel operate.

Beyond these two firms, there are almost 500 small firms. It is interesting to note that when locally developed software firms do grow, they have often been the targets of acquisitions by larger, typically American, firms. JetForm is the classic example. It was taken-over by Adobe Systems of San Jose, California.

Microsoft Corporation, the world's largest software company employs over 54,000, including about 26,000 in Puget Sound, its Washington State Global campus. But considering

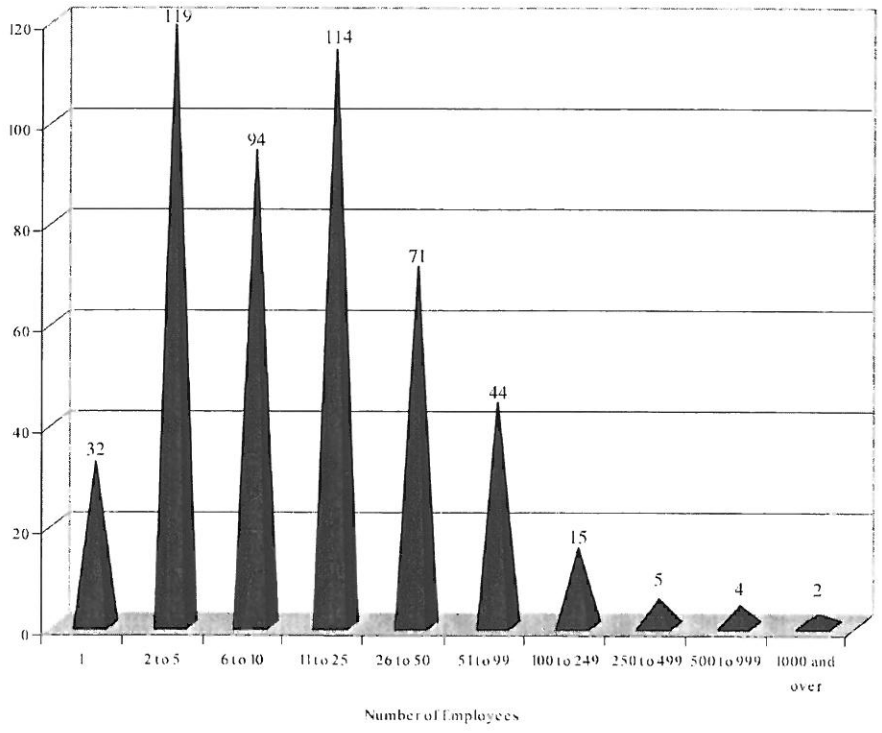

Figure 5: Distribution of software firms (total of 500 firms).

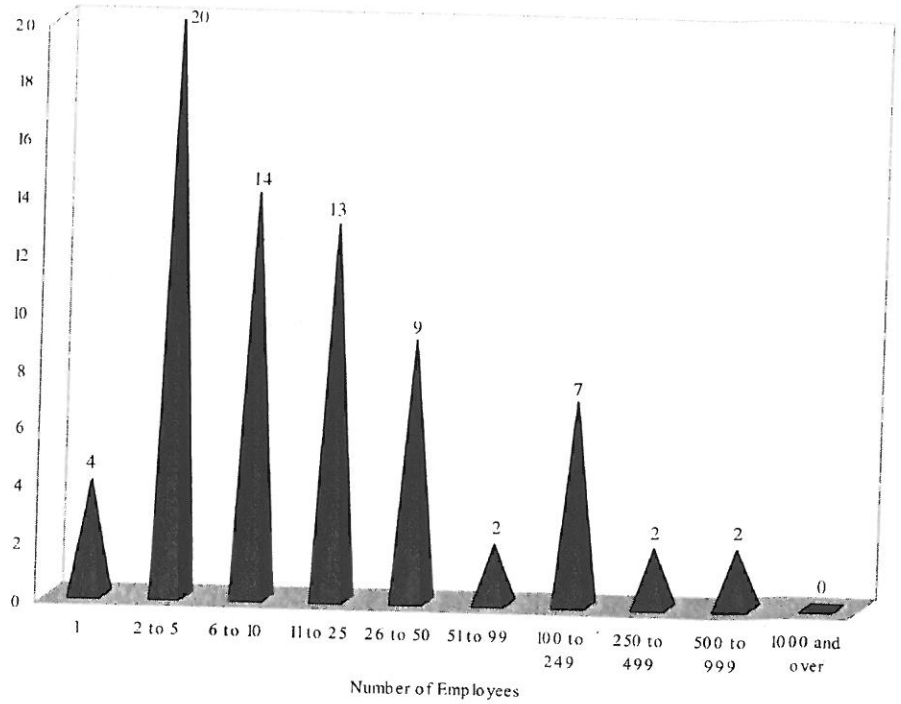

Figure 6: Distribution of life sciences firms (total 73 firms).

the dominance of this company in the many product and service markets that it serves, this total may appear small. Therefore, size in terms of employment in the software industry is less of an issue than in other industries such as telecommunications equipment manufacturing.

3.7. Life Sciences

Life sciences are a new emerging area of strength for Ottawa (see Figure 6).

This strength is spread amongst a number of different areas of life sciences, which were identified by the Ottawa Life Sciences Council and are summarized in Table 3.

Table 3: Regional research strengths in life sciences.

Ag-biotech	Biochips and Biosensors
Bioproducts and Materials	Clinical Trials
Diagnostics	Genomics and Proteomics
Information Technologies	Medical Devices and Imaging
Pharma, Biopharma and Biologics	Stem Cells and Cell Therapies

Source: Ottawa Life Science Council.

Total employment in life sciences firms is estimated at 3,700 and further 7,300 work in the field of life sciences in universities and hospitals. The private sector firms are estimated to earn $650 million a year in revenues. The strengths of the University of Ottawa's medical school (4th highest level of medical research in Canada), as well as two Biotechnology Incubation Facilities and existing government laboratories, create an excellent atmosphere for life sciences firms. This environment is needed in a sector where product development can be both very costly and time consuming (see also the chapter by Armit this volume).

MDS Nordion is the star in the local life sciences sector. The firm was created out of a series of crown corporations, including Atomic Energy of Canada Limited (AECL), to take advantage of the new medical applications of nuclear technologies that were then developed. This dates back to the mid-1940s and the firm has had roots in Ottawa ever since. Today it represents approximately 19% of the parent MDS Corporation's revenues ($1.8B in 2002).

Encouraging for the future development of the sector is the group of 7 firms with between 100 and 249 employees. Many of these firms develop and sell products into the life sciences sector. These firms include QNX Software, Fisher Scientific Limited and Med-Eng Systems. QNX develops software for a variety of industries including medical instrumentation. Fisher Scientific Limited, a Canadian subsidiary of Fisher Scientific International, provides a wide range of products including instruments and equipment for laboratories and clinics. Med-Eng develops and sells a wide range of human protective clothing including bio-chemical blast protection suits. These suits are used for a variety of purposes including police/military work. The firm has an active research program in Ottawa.

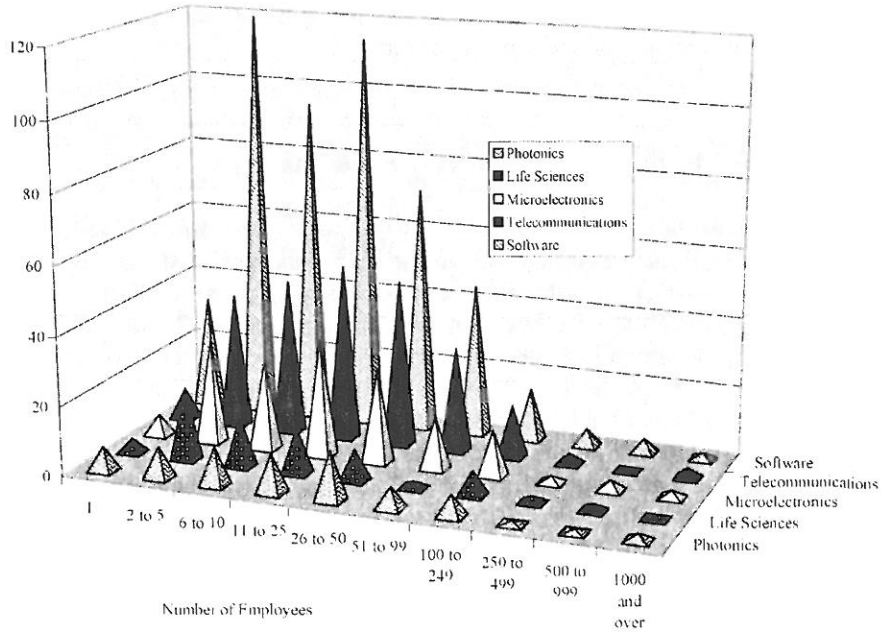

Figure 7: All technology sectors.

3.8. Intersectorial Comparisons

Figure 7 plots the size distributions of the various sectors against each other.

The size of the software industry, based on the number of employees is very distinct in this image. The maturity of the telecommunications and microelectronics sectors are also visible by their relative concentrations in larger sized firms. Finally, it is important to note that the size distributions are quite consistent across each of the sectors studied.

4. Comparison of Silicon Valley North with Other Countries and Regions

Are Silicon Valley North (SVN) firms very different from high-tech firms in other parts of the world? How do they compare in terms of size and size distribution? And, if there are significant differences, can they be attributed to easily identifiable causes? Answering those questions will provide a better idea of the positioning of SVN firms in a Canadian and an international context, information very relevant in a global world with increasing competition between world cities. As shown below, the largest Canadian firms tend to be significantly smaller than the largest firms in most developed countries, and the largest Canadian technology firms tend also to be significantly smaller than the largest technology firms in California. However, a comparison of SVN high-tech firms with Oxfordshire (UK) and with Silicon Valley (U.S.) high-tech firms shows that SVN firms tend to be larger on the average than high-tech firms in those two regions. What does that tell us about the Ottawa region and about Canadian firms in general?

4.1. Comparison with the Largest Canadian Corporations

Canadian firms tend to be relatively small by world standards. As shown in Table 4, Canada's largest firms, George Weston, ranks 269 among Fortune Magazine 500 Global firms (Fortune 2003), compared, for example, with rank 1 for Wal-Mart, the largest U.S. firm, and rank 4 for Shell, the largest Dutch/UK firm. Among Canadian firms, SVN firms tend also to be relatively small. As shown in Table 4, the largest firm with close links to Ottawa which appears on the list, Nortel Networks, is 11th in size in Canada and 470th in size in the world. Silicon Valley North firms are therefore small by world standards.

The largest firms listed in Tables 4 and 5 are either in the global retailing business (Wal-Mart), natural resources and energy (Shell, Total), manufacturing (Daimler Chrysler, Toyota), banking (Royal Bank, Scotia Bank), or are conglomerates spanning a number of sectors (George Weston, Power Corporation). Those are not the primary activities of SVN firms and therefore do not make for a fair comparison. Bombardier stands out as the largest Canadian "technology" firm, its size being driven by the nature of its business (transportation, aeronautics), again not representative of the Ottawa type of activity.

Table 4: Largest Canadian Corporations.

Company	Rank in Canada	Rank in the world	Revenues ($mUS)
George Weston	1	269	17,476.0
Bombardier	2	329	15,115.9
Royal Bank	3	337	14,771.7
Onex	4	344	14,424.1
BCE	5	390	13,020.7
Magna International	6	391	12,971.0
Alcan	7	402	12,540.0
Power Corporation	8	418	12,108.9
ScotiaBank	9	432	11,633.1
CIBC	10	464	10,835.8
Nortel Networks	11	470	10,701.0
Manulife	12	479	10,526.6

Source: Fortune (2003), Fortune Global 500.

4.2. Comparison with the Largest International Corporations

The second step is to position Canadian firms with respect to the largest firms from other countries. Table 5 provides a list of the largest firms from other countries from the 2003 edition of Fortune Magazine Global 500. The list includes the country, rank and annual revenues for each corporation.

Table 5: Largest firm from selected countries.

Company	Country	Rank in the world	Revenues ($mU.S.)
Wal-Mart	United States	1	246,525.0
Shell	Netherland /United Kingdom	4	179,631.0
Daimler Chrysler	Germany	7	141,421.1
Toyota	Japan	8	131,754.2
Total	France	14	96,944.9
Nestle	Switzerland	38	57,598.9
Assicurazioni	Italy	44	53,598.9
Samsung	Korea	59	47,605.6
China National Petroleum	China	69	44,864.4
⋮	⋮	⋮	⋮
George Weston	Canada	269	17,476.0

Source: Fortune (2003), Fortune Global 500.

Comparing Canadian firms with the largest firms from selected countries, it is possible to conclude that Canadian firms are smaller ones. The largest Canadian firm, George Weston, has annual revenues of $17,476 millions U.S. and ranks 269 in the world. It is therefore not surprising to find that Silicon Valley North firms are relatively small because this seems to be a Canadian characteristic.

4.3. Comparison of Largest Canadian and Californian High-Tech Firms

Canada and California have approximately the same population and well educated labour forces. Rather than comparing Canadian and SVN firms with the largest firms in the world, it may be more logical to compare Canadian high-tech firms with Californian high-tech firms due to similar sectors and state/country with similar populations.

As it appears from Table 6, Canadian technology firms tend to be much smaller than Californian technology firms. Whereas Californian firms tend to be U.S. multinationals headquartered in California, a number of Canada's largest high-tech firms are branches of foreign multinationals, some with significant presence in SVN. Only one large Canadian high-tech firm, Nortel Networks, has a significant presence in SVN.

SVN has a number of software firms who are world leaders in their market segment (Table 7). Those firms are however small (in terms of revenue) by world standards.

Table 6: Largest California and Canadian Technology Firms.

Californian Tech Firms (World-Wide Revenue)[a]		**Canadian Tech Firms (World-Wide Revenue; Telecom Carriers Excluded)[b]**	
Company	**Revenue ($mU.S.)**	**Company**	**Revenue ($mCDN)**
Hewlett-Packard	58,588	Bombardier	23,790
McKesson	50,006	Nortel	10,621
Intel	26,764	Celestica	8,289
Cisco Systems	18,915	General Electric Canada	3,379
Sun Microsystems	12,496	Siemens Canada	3,100
Solectron	12,276	Pratt and Witney Canada	2,600
Computer Sciences	11,426	H. P. Canada	1,800
Oracle	9,673	ATI Tech.	1,026
Science Application Int	6,104	Xerox Canada	1,519
Agilent	6,010	EDS	1,427
Apple Computer	5,742	Linamar	1,360
Amgen	5,523	Honeywell Canada	1,323

[a] Fortune 500 World largest firms 2003.
[b] ROB Top Tech 2003.

Table 7: Largest software firms in Ottawa (World Wide Revenue).

Company	Revenue ($mCDN)
Cognos	500.2
Corel	130.3
Pieta tech.	13.5
MXI	10.1
Autoskill	7.9
Watchfire	6.9
Hemera	5.7
TrueArc	5.2
FreeBalance	5.0
Taske Tech.	4.2
Data Kinetics	4.1
KOM Networks	4.1
Workstream	3.1

Source: Branham Group 2003.

4.4. High-Tech Firms in Silicon Valley North, Oxfordshire(UK) and Silicon Valley(U.S.)

We compared the distribution of SVN high-tech firms by size with that of firms in Oxfordshire and in Silicon Valley. Size is estimated by the level of local employment, a measure of a firm's contribution to local economic activity, local value added, rather than by sales level. Local employment has the advantage of being easily measured and of being publicly available whereas sales level is seldom publicly available for private firms and does not always represent fairly the firm's real contribution to economic activity (are Wal-Mart's sales really representative of its contribution to global wealth?).

Data was obtained for two high-tech regions, one in the United Kingdom (Oxfordshire) (Chadwick *et al.* 2003)[3] and one in the U.S. (Silicon Valley) (Zhang 2003). Oxfordshire, the region surrounding Oxford University in the United Kingdom, has a technology profile that is comparable to SVN: 1,400 high-tech firms[4] (including an estimated 60 university spin-offs) and 36,700 high-tech jobs in 2001, about three-quarters of the firms being home-grown, and about two-thirds having been founded since 1991 (Chadwick *et al.* 2003). In term of employment, the most important high-tech activities in Oxfordshire are R&D (8,200 jobs), software (4,300 jobs), web/internet and other computer-related services (3,650 jobs), precision instruments, medical and optical equipment (5,050 jobs), biotech,

[3] We are grateful to Professor Helen Lawton Smith who has facilitated our access to data prepared by the Oxfordshire Economic Observatory.

[4] In this chapter, we have to use the terms "firm" and "establishment" interchangeably in order to integrate the basic concepts used for analysis in the Oxfordshire report (Chadwick *et al.* 2003), the Silicon Valley report (Zhang 2003), and the OCRI data.

pharmaceuticals and medical diagnostics (3,250 jobs), technical consultancy and testing (3,250 jobs), computer equipment (1,850 jobs), electronic and communications equipment (1,550 jobs), telecommunications services (2,350 jobs), and motor-sports and automotive engineering/design (2,500 jobs; Chadwick *et al.* 2003). Silicon Valley, located not far from Stanford University in California, has been the role model for most high-tech regions and provides an interesting benchmark for comparative analyses. It is much larger than SVN, with 25,787 firms employing 672,825 persons in 2001 (Zhang 2003). Computers/communications is Silicon Valley's largest sector with 1,127 firms and 150,974 jobs, followed by software (4,505 firms, 114,639 jobs), innovation services (6,257 firms, 112,150 jobs), professional services (11,897 firms, 103,856 jobs), semiconductors (816 firms, 103,443 jobs), bioscience (847 firms, 51,854 jobs), and defence/aerospace and environmental with, jointly, 338 firms and 35,912 jobs (Zhang 2003).

The comparative analysis that follows includes all 25,787 Silicon Valley firms, the breakdown of the data by sector not being available. Silicon Valley data therefore include bioscience, computers/communications, defence/aerospace, environmental, semiconductor, software, professional services, and innovation services. To focus the analysis on firms operating in similar fields, only biotechnology, software, telecom services, computer equipment, electrical/electronic equipment, instruments, technical consulting and testing, other R&D, other computer services, and aerospace firms were retained for Oxforshire (a total of 1,095 firms). For SVN, telecommunication, microelectronics, photonics, software, and health sciences were kept for the comparative analysis (a total of 1,043 firms; Zhang 2003). It is clear that there is not a perfect match in terms of data for the three regions in our comparative analysis. However, the data retained for the analysis includes most high-tech firms in telecommunications, microelectronics, software, photonics, and bio/health sciences.

Data on the distribution of high-tech firms by size (number of local employees) in the three regions appears in Table 8.

That data was used to prepare three graphs (for Oxfordshire (see Figure 8), for Silicon Valley (see Figure 9), and for Ottawa (see Figure 1 presented earlier in this chapter) for a visual analysis of similarities and differences between regions.

Table 8: Comparing technology regions, all high-tech firms.

Oxfordshire (1,095 Firms)		**Silicon Valley (25,787 Firms)**		**Ottawa (1,043 Firms)**	
1–5	49.2%	0–4	62.0%	1–5	26.40%
6–10	16.7%	5–9	13.2%	6–10	18.20%
11–25	14.6%	10–19	9.2%	11–25	21.40%
26–50	8.8%	20–50	8.6%	26–50	16.20%
51–99	4.9%	51–100	3.2%	51–99	9.30%
100–249	3.3%	101–250	2.2%	100–249	5.40%
250–499	1.6%	251–500	0.8%	250–499	1.20%
500–999	0.4%	501–1,000	0.4%	500–999	1.10%
1000 and over	0.5%	1001–2,500	0.2%	1000 and over	0.9%
		Over 2,500	0.1%		

Sources: Ottawa (OCRI 2003), Silicon valley (Zhang 2003), Oxfordshire (Chadwick *et al.* 2003).

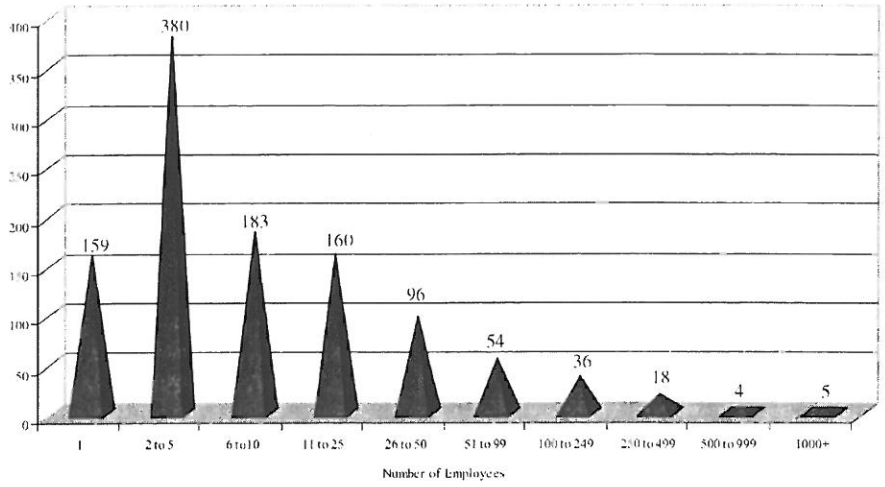

Figure 8: Distribution of firms in Oxfordshire (total 1,095).

As illustrated by the three distributions, the three regions have a high percentage of very small firms (0–4 or 5 employees) and very few firms with very large local employment, a distribution that reflects quite well the size distribution of all firms among all sectors in the British, Canadian, and American economies, which are dominated by very small and small firms. This is also representative of entrepreneurial milieus, with a high rate of firm creation

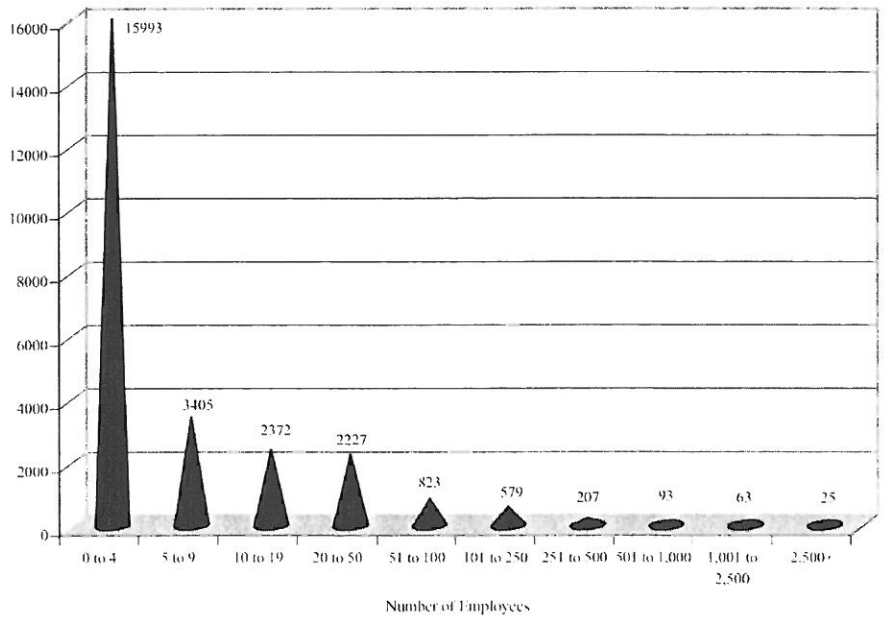

Figure 9: Distribution of firms in Silicon Valley (total 25,787).

Table 9: Comparing regions, all high-tech firms with 5 or 6 employees and greater.

Oxfordshire (624 Firms)		Silicon Valley (9,794 Firms)		Ottawa (768 Firms)	
6–10	32.9%	5–9	34.8%	6–10	24.7%
11–25	28.8%	10–19	24.2%	11–25	29.0%
26–50	17.3%	20–50	22.7%	26–50	22.0%
51–99	9.7%	51–100	8.4%	51–99	12.6%
100–249	6.5%	101–250	5.9%	100–249	7.3%
250–499	3.2%	251–500	2.1%	250–499	1.7%
500–999	0.7%	501–1,000	0.9%	500–999	1.4%
1,000 and over	0.9%	1,001 +	0.9%	1,000 and over	1.2%

Sources: Ottawa (OCRI 2003), Silicon valley (Zhang 2003), Oxfordshire (Chadwick *et al.* 2003).

and many small firms, and only a very small percentage of firms becoming large or very large. SVN has a smaller percentage of very small firms than the two other regions (26.4% of firms with 1–5 employees, compared with 49.2% in Oxfordshire (1–5 employees) and 62% in Silicon Valley (0–4 employees) and a larger percentage of mid-size and large firms. This observation could be skewed by the very large number of very small firms in Silicon Valley, either a special characteristic of that region, or a difference due to data collection. To correct for the potential bias due to the number of very small firms, another analysis was done, focusing on firms with 5 or 6 employees and more (see Table 9). We found that in SVN, 24.2% of those firms have 50 employees or more, and 2.6% have over 500 local employees, compared with 18.2% and 1.8% respectively in Silicon Valley, and 21% and 1.6% respectively in Oxfordshire.

Why does there seem to be less very small firms and more medium and large firms in SVN than in Oxfordshire and in Silicon Valley? The difference observed between SVN and the two other regions in this comparative study may be due to differences in data collection or differences in the sectors included in our study. SVN data comes from the annual Ottawa Centre for Research and Innovation survey, a self-reporting exercise, which almost certainly misses a significant number of self-employed consultants (Silicon Valley's "zero employee" firms) or very small firms. Oxfordshire data was developed from a number of public databases, firm selection and sectoral classification being based on scientific criteria (Chadwick *et al.* 2003). Silicon valleys data was based on the National Establishment Time-Series, a data set based on the Dun & Bradstreet data sets, and from the Venture One data set on venture-backed firms (Zhang 2003). As noted previously, even if the high-tech sectors included in our comparative analysis are similar, sect oral classifications and definitions were developed independently and may not be exactly similar. The differences observed may also be partly due to differences in regional environments and differences in individual firms strategies. Research on systems of innovation has clearly illustrated the relationship between national and regional characteristics and firm development. Regional culture, education, R&D activity, business and commercialization expertise, availability of informal and formal venture capital are some of the factors often considered in the analysis (Corona *et al.* 2003). In our case, the extraordinary influx of Venture Capital in SVN between 1999 and

2002 may explain in part the relatively larger size of firms in the region in comparison with the other regions. Firm size is also driven by firm strategy, a key element in the development of a business enterprise and in its growth. Individual strategies, in addition to regional factors, may also explain some of the differences observed between SVN, Silicon Valley, and Oxfordshire.

5. Conclusion: A "Glass Ceiling" for SVN High Tech Firms?

"Clusters" are a topic that have become of both analytic and political interest (recall, once again the Innovation Strategy of the Canadian federal government). The idea begins with the observation that economic growth is local. Cities and their communities drive the prosperity of nations. They attract, retain and transform foreign direct investment as well as creative, talented, people (de la Mothe & Mallory 2003). Institutions are key, such as the National Research Council of Canada. Firms are of course critical. Ottawa has a blend of at least 5 industrial clusters. Universities and colleges, such as the University of Ottawa, Carleton University, Université du Quebec en Outaouais, Cité Collégiale and Algonquin College, provide the region with highly skilled talent. Entrepreneurial financial institutions are critical, offering an industrial suave range, from love capital through equity and FDI. Moving up the later stages of capital, the roles of investment, tax and monetary policies is central, as is the opportunity to be involved with federal trade missions which open markets. The "environment" is also key. The availability of low crime rates, of cultural venues, of entertainment, of athletic facilities, including golf clubs, bike paths, running tracks, tennis clubs, and the like are essential.

Clusters — or taken down a level or two lower — communities and alliances have long been of importance to the understanding of firm behaviour and corporate strategy. In part this is because we understand that the etymological origins of the word "competition" do not emphasize conflict — as is often assumed in business schools — but instead means "to seek together." By "seeking together," a firm can effectively trade on its strengths —

Table 10: Forms of competition.

Old Competition	**New Competition**
Prices	*Re-Definitions of*
Costs	Core business
Productivity	Core competences
Capital and labour	Value added (from what you have to what to know and do)
Savings	Expanded value chain
Ownership	Social organization and innovation
	Notions of
	Access
	Lean production

be it in technology, capital or distribution channels — and shore-up its weaknesses, create synergies, moderate risk exposure, and access value chains. Much recent literature has begun to discuss this in terms of knowledge management (de la Mothe & Foray 2001; de la Mothe & Cimoli 2002) and in terms of networks (de la Mothe & Link 2002). Thus, the variety of forms of collaboration accurately underscores the importance of alliances as a means through which to create value and stimulate innovation. But alliances are not simply a feature of inter-firm relationships. They are not restricted to R&D consortia or to knowledge transfer relationships between private and public institutions. Indeed, increasingly alliances can help us understand the dynamics of larger innovative communities such as cities and indeed they are being used as strategies to achieve local growth. This is a far cry from the notion of industrial districts of the early 20th century and the Ricardian notion of comparative advantage. It shows even an important evolution from Porter's notion of competitive advantage towards his assessments of locations for innovation. Ottawa features many of these requisite advantages, as noted in Table 10.

This discussion of clusters, coupled with the research findings that we have presented in the chapter, provide us with some observations. Our first observation is that, it appears that SVN has proportionately less very small firms and more medium and large high-tech firms than Silicon Valley and Oxfordshire. Secondly, large Canadian high-tech firms tend to be small when compared with the largest high-tech firms in California, a State with a population similar to Canada's.

Acknowledgments

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References

BBC News (2003). World edition. *Ericsson returns to profit.* http://news.bbc.co.uk/2/hi/business/3226395.stm. Accessed on 30 October 2003.

Chadwick A., Glasson J., Lawton Smith H., Clark G, & Simmie J. (2003). *Enterprising Oxford. Volume 2: The anatomy of the Oxfordshire high-tech economy*. Oxford, UK: Oxfordshire Economic Observatory.

CMC (Canadian Microelectronics Corporation) (2003). http//:www.cmc.ca.

Corona, L., Doutriaux, J., & Mian, S. (2003). Regional innovation in NAFTA countries: Case studies of selected innovation poles. Pre-Publication Working Paper. University of Ottawa #03–53.

de la Mothe, J., & Cimoli, M. (2002). Technology, growth and development. In: J. de la Mothe (Ed.), *Science, technology and governance*. London, UK: Continuum.

de la Mothe, J., & Foray, D. (Eds) (2001). *Knowledge management in the innovation process*. Boston, MA: Kluwer.

de la Mothe, J., & Link, A. N. (Eds) (2002). *Networks, alliances and partnerships in the innovation process*. Boston, MA: Kluwer.

de la Mothe, J., & Mallory, G. (2003). Local knowledge and the strategy of constructed advantage: The role of community alliances. *International Journal of Technology Management*, December.

Doutriaux, J. (1991). High-tech start-ups, better off with government contracts than with subsidies. *IEEE Transactions on Engineering Management, 38*(2), 127–135.

Doutriaux, J. (2003). University-industry linkages and the development of knowledge clusters in Canada. *Local Economy, 18*(1), 63–79.

Fortune (2003). Fortune Global 500. *Fortune Magazine* (July 21, pp. 97–126).

Government of Canada (2001). *Achieving excellence: Investing in people, knowledge and opportunity.*

Government of Canada (2002). *Knowledge matters: Skills and learning for Canadians.*

ICF Consulting (2000). *Choosing a future: A new economic vision for Ottawa.* August.

ICF Consulting (2003a). *Innovation Ottawa: A strategy for sustaining economic generators — Executive summary.* January 14.

ICF Consulting (2003b). *Innovation Ottawa: A strategy for sustaining economic generators.* January 22.

OCRI (Ottawa Centre for Research and Innovation) (2003). http//:www.ocri.ca.

OLSC (Ottawa Life Sciences Council) (2003). http//:www.olsc.ca.

OPC (Ottawa Photonics Cluster) (2003). http//:www.ottawaphotonics.com.

Ottawa Region (2003). http//:www.ottawaregion.com.

Ottawa Business Journal (2003). http//:www.ottawabusinessjournal.com.

Papadopoulos, N. (1997). *Competitive profile of a world city: Ottawa-Carleton compared to leading technology centres in North America. A brief for the Ottawa-Carleton board of trade.* Ottawa, Ontario, Canada: IKON Research Group, School of Business, Carleton University, October.

Photonics Dictionary (2003). A Laurin Web Site, http://www.photonics.com/dictionary/lookup/XQ/ASP/url.lookup/entrynum.3996/letter.p/pu./QX/lookup.htm. Accessed on 28 November 2003.

Reich, R. (1991). *The work of nations: Preparing ourselves for 21st-century capitalism.* New York: Alfred A Knopf.

Reich, R. (2003). Jobless in America. *CIO Magazine* (Fall/Winter). http//:www.cio.com/archive/092203/reich.html.

Re$earch Money Inc. (2003). *Task force seeking answers on how to grow high-tech firms in era of global competition.*

Statistics Canada (2001). *Census.* Ottawa, Ontario, Canada: Statistics Canada.

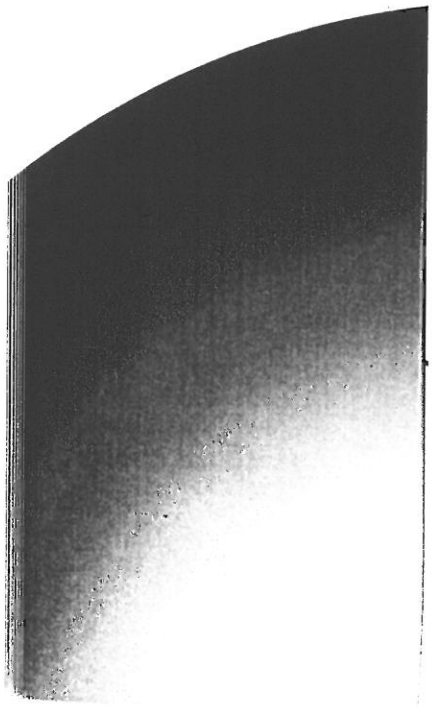
The Canadian Encyclopaedia (2nd ed.) (1988). Edmonton, Alberta, Canada: Hurtig Publishers.

Zhang, J. (2003). *High-tech start-ups and industry dynamics in Silicon Valley.* San Francisco: Public Policy Institute of California.

SILICON VALLEY NORTH

A HIGH-TECH CLUSTER OF INNOVATION AND ENTREPRENEURSHIP

Edited by
Larisa V. Shavinina



SILICON VALLEY NORTH

A HIGH-TECH CLUSTER OF INNOVATION AND ENTREPRENEURSHIP

The Silicon phenomenon was, is, and will be an extremely important phenomenon in the accelerated technological, scientific, and economic development of countries and regions. Silicon Valley North (SVN) is the high tech capital of Canada, the nation's most developed and dynamic technology sector, which includes multiple clusters in telecommunications, software, photonics, and life sciences. It gave birth to many well-known companies such as Corel, JDS Uniphase, Mitel, Newbridge Networks, Nortel Networks, Digital Equipment of Canada, just to mention a few. A lot of literature describes Silicon Valley in the US, Silicon Islands in Asia, and so on. Despite the quite evident importance of Silicon Valley North for the regional, national, and international technological development (especially when Nortel Networks and JDS Uniphase became global leaders in their fields and expanded in explosive fashion), this phenomenon is far from being well understood. Because of this, a book on the Canadian Silicon Valley is an exceptionally timely endeavor.

Silicon Valley North: A High-Tech Cluster of Innovation and Entrepreneurship offers a broad and deeply thematic analysis of one particular innovative cluster—Silicon Valley North. The book is devoted to the multidimensional and multifaceted nature of Silicon Valley North, its history, current state and future developments. The reader will obtain expert insight into what SVN is all about by acquiring a comprehensive and "panoramic picture" of SVN within a single book. The reader will develop an accurate sense of what spurs high tech start-up companies in SVN toward their exceptional performances, and how to apply these insights to his or her unique regional context.

The Contributors

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