



OUTLOOK 2020 INITIATIVE

BC'S ADVANCED TECHNOLOGY SECTOR: REACHING FOR THE NEXT LEVEL

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NOTICE TO READER

The objective of the Business Council of BC's Opportunities BC 2020 initiative is to create a positive vision and agenda for the economic future of British Columbia. To this end, the initiative will focus on strengthening British Columbia's export base and other economic activities (such as research and development investment) that generate income for the province.

For the purposes of this paper, the technology industry will include all sectors encompassed in the broad definition outlined by BC Stats and the government of BC, which include information and communication technology (ICT) – hardware and software, film and new media, life sciences and aerospace. While these sectors appear disparate on the surface, they are all knowledge-based industries.

As part of the Opportunities BC 2020 series, this paper follows a common format as outlined by the Business Council and addresses the following questions, which provide the general framework for each of the 2020 industry topic papers:

1. What role does the technology industry play in BC's economy? How does the industry generate export earnings for BC? It is realistic to expect that the industry can have a larger economic footprint in the future?
2. What major trends (internal and external) will shape the economic environment for the technology industry over the next decade?

This paper lists high-level recommendations regarding issues that need to be addressed by all stakeholders (not just government) to strengthen the technology sector and facilitate its growth for the benefit of the province. In reviewing this paper, the reader should keep in mind that BC is a small, open, sub-national economy. This affects the actions that can be taken to build a more supportive environment that will ensure the success of BC's technology industry.

At the time this paper is being drafted, the global economy is experiencing a financial crisis and heading towards recession. This down turn is unprecedented in its global scale and experts are struggling to assess the depth and length of the recession and its potentially lasting impacts. This global economic crisis will undoubtedly impact the short and medium term outlook for our industry, but we don't believe that it fundamentally changes the long term outlook for the technology sector. Economic growth will return and, innovation and technological progress will continue. To what extent achieving our long term goals is impacted by the current economic downturn is not predictable at this point, but the validity of the fundamentals, of our goals and of the key recommendations remains unchanged

This paper was authored by the BC Technology Industry Association with the help of many stakeholders who have reviewed, discussed and contributed to its content. It is not intended to reflect only the BCTIA's position, but rather to provide a broader perspective encompassing the views of all technology sector stakeholders.

Special thanks go to co-author Steve Thomson of SL Thomson and Associates Consulting; the BCTIA Board of Directors; colleagues from Life Sciences BC, New Media BC and WINBC; and other stakeholders for their constructive reviews and inputs. The BCTIA would also like to thank the Business Council of British Columbia for making the Opportunities BC 2020 project possible, and for providing valuable feedback that was instrumental in the creation of this paper.

Vancouver, BC
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Pascal Spothelfer
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This paper discusses the status of the technology industry, broad trends that will shape its future and key issues that must be addressed to ensure that this sector fulfills its potential. It provides a general overview, as well as a number of recommendations that represent progressive and comprehensive approaches to problems that currently restrict the growth of BC's technology industry. Also, because the advanced technology sector is an integral part of BC's economy, it will be examined within the larger context of the province's economic situation. We hope that this paper will serve as a framework for more detailed analysis of technology sub-sectors, as well as specific issues that affect the industry overall.

The technology sector in BC is still small. In 2007, it generated 5.9% of British Columbia's GDP, employed 4.3% of the total workforce in the province and generated a small fraction of overall exports. However, despite its small size, there are a number of reasons to care about BC's technology industry. First, it provides many high-paying jobs, with technology workers earning 50% more on average than workers in BC overall. Second, for the past five years, the technology industry has consistently outgrown the rest of the economy, which indicates its future potential. Third, all sectors of the economy rely on technology to remain competitive and increase productivity. And most importantly, knowledge-based industries are the future economic foundation for highly developed industrial countries such as Canada.

BC has traditionally built its wealth on its natural resources. However, as the downturn in the forestry industry indicates, we need to reduce our reliance on natural resources. Our future will depend on our ability to create wealth from our human resources. To this end, the knowledge-based industries:

- Provide sustainable, high-paying jobs
- Thrive on research and development
- Benefit from high levels of education
- Maximize the value of intellectual property
- Essential for productivity improvements across industry sectors
- Allow ecologically sustainable economic development
- Foster a culture of creativity and innovation that ultimately creates wealth for all

In the future, the success of these industries will be the ultimate differentiator between the have and have-not jurisdictions, and the advanced technology sector is, in many respects, the linchpin for all knowledge-based economies.

This is not to say that we should abandon British Columbia's natural-resources-based industries. We should maintain the strength of this sector which, thanks to an abundance of natural resources and the well-established industries that harvest them, will continue to be an essential part of our economy and a key contributor to our exports. However, the labour content in these industries has been dramatically transformed due to productivity pressures in the face of global competition. Similar trends can be observed in the manufacturing sector where an increasing number of jobs have moved to emerging economies because of labour costs. The future job market will consist of jobs that must be local due to their nature (construction, consumer services, etc.) and those that can be sustained in high-cost environments due to the added value they create, such as jobs in the knowledge-based industries in general and the technology industry in particular.

There is already competition for knowledge-based companies in the industrialized world. This competition will continue to increase, and British Columbia is extraordinarily well positioned to come out a winner. We are blessed

with a diversified economy, a very high quality of life, a heterogeneous and cosmopolitan society, a strong education system, a highly skilled workforce, solid public sector financials, an increasingly business-friendly legal environment and a very strong reputation worldwide, which will only increase after the 2010 Vancouver Olympic and Paralympic Winter Games.

However, to become a sustainable and significant contributor to BC's economy, the technology industry needs to grow at a faster pace than it historically has. We have to commit to a strategy that proactively take steps to grow larger technology companies in the province, export dramatically more, build strong clusters, build a truly world class education system and equip our government to lead these efforts for the long term..

The decade from 2010 to 2020 offers our generation a unique opportunity to build a world-class diversified economy with strong knowledge-based industries, including the advanced technology sector. Missing this opportunity would put BC at a disadvantage for generations to come.

Government initiatives alone cannot grow our technology industry. Society as a whole must buy into the concepts of world-class education at all levels, big ideas and ambitions, long-term thinking, rewarding entrepreneurialism and success, hard work and re-investment.

BC has for too long sat back and benefitted from its natural wealth, whereas other areas of the world not blessed with such resources have made their economic transitions already. Having no real alternative, countries such as Ireland, Israel and Switzerland have established knowledge-based economies, and we are playing catch-up in this domain already. We need to be much more aggressive in pursuing the kind of future we want for British Columbia, and we must be deeply committed to doing the work necessary to achieve what we are capable of.

Creating a business friendlier environment will not be sufficient to win in this global race. In the seventies BC made large investments into its infrastructure (roads, hydro) which dramatically increased our competitiveness as will current investments in gateway infrastructure. BC needs to act boldly and strategically to invest for the long term into our knowledge based industries, including the technology sector.

We strongly recommend subscribing to the following ambitious but achievable goals and measure progress against them as we implement measures to achieve them:

- Transform the industry's structure to include anchor companies for each relevant sub-sector, with 10% of the technology companies having 50 or more employees
- Triple the size of the technology sector size in terms of GDP to \$30B
- Increase revenues generated by the sector to \$50B
- Increase the number of technology sector employees by 75% to 142,000
- Grow exports to 35% of the sector's revenues or \$17.5B

Achievement of these goals will not only create an economic future for the province overall, but also help to build a stronger society in BC. One that is highly educated; economically stable; innovative and creative; adaptable; and able to adopt progressive paradigms such as environmental sustainability, social justice, tolerance and security, as well as entrepreneurialism, celebrations of success and wealth creation.

EXECUTIVE SUMMARY

- Having largely developed within the past 40 years, the technology sector in BC is relatively young when compared to BC's traditional industries such as mining, forestry, transportation, and even tourism.
- While BC's technology sector is being reviewed for its export potential, the important role that the technology sector plays in all of BC's domestic sectors cannot be downplayed. IT infrastructure, for example, is increasingly at the core of every sector of the economy including government, financial services and health care while Clean technologies and Life Sciences technologies help to enrich the lives of all British Columbians.
- To a large extent, the BC technology industry has grown out of support for BC's primary economies, with additional innovation spinning-out from the province's research universities to provide the impetus for the industry to reach into new market segments.
- While BC's technology industry has helped BC's primary industries to be more productive and successful, in turn the primary industries have shaped natural strengths that hold BC-engineered products in good stead when selling to the world.
- Clusters of strength are emerging where companies complement each other with overlapping products and services and similar market targets. Specifically, these clusters are appearing in:
 - Biotechnology
 - Digital Media
 - Fuel Cells and Clean Energy
 - Wireless Telecommunications
 - ICT
- The province's leading universities have a reputation for developing a wide range of engineering and scientific talent, from electrical and mechanical engineering to computer science, advanced materials, photonics and life sciences.

The diversity of the talent pool in such a small geographic area enables cross-disciplinary innovation and enables researchers and companies to create a range of technologies that service almost every sector of the economy.

- Unfortunately the breadth of the technology sector, when combined with the relatively small size of BC technology companies, does not allow for a lot of depth in any one area. This creates a significant issue of scalability as the BC technology industry competes against other pools of talent around the world.
- The technology industry continues to play an increasing role in BC's economy, delivering an ever larger percentage of our GDP (although the relative contribution of the technology sector is down since 2004 due to the booms in the construction in commodities sectors). In the past few years, BC's high-tech industry has also outpaced the overall economy in GDP growth, accounting for approximately 5.9% of GDP in 2007.

- Employment in the technology sector has increased by nearly two-thirds since 1991, and now exceeds the previous heights reached during the 'dot-com bubble' in 2000 and 2001.

With 81,140 employees and a total payroll that exceeded \$4billion in 2007, the BC technology sector now employs more people than the mining, forestry, and oil-and-gas exploration industries combined.

- While the technology sector not only creates high-paying jobs, it also creates opportunities for significant wealth creation and there are an increasing number of examples in BC where founders and investors have profited quite considerably from their successes, both through gains from acquisitions as well as from profits derived from successful operations.
- While start-up costs have historically been significant, particularly in sectors such as bio-technology where R&D, trials and approvals can often take 15 years, in most technology sectors, output is highly scalable. Often-times, the marginal cost of creating one more unit of output (such as one more piece of hardware, one more piece of software, or one more dose of medicine) is negligible. Therefore, once successfully launched, new technology products can enable the significance growth of a technology company without necessarily requiring large amounts of capital to scale the operations.
- The technology industry in BC is mostly comprised of smaller companies. Of the 8,600 technology companies identified by BC Stats, 7,000 have less than 10 employees with 5,800 having less than five employees. Only 348 technology companies in Bc (of all descriptions) had more than 50 employees.
- While the BC Technology Sector produced \$18.1 billion in revenues in 2007, only \$2.7 billion of that revenue (18%) was derived from export revenues.
- A significant challenge that BC's technology industry faces is a shortage of skilled technology workers and senior technology management talent. In the 2007 TechTalentBC Labour Demand Study undertaken by the BCTIA, it was found the industry was expecting to create 10,000 new jobs in 2007 and 2008 (likely a net of 5,000 new jobs).

The demand for new talent is considerably higher than the output of BC's post-secondary institutions. Therefore, the only way to meet the demand is recruit talent from other jurisdictions.

While British Columbia has an excellent pool of 'technologists' these are only one component of the talent pool needed to drive a successful company. Unfortunately, most BC technology companies tend to have a proportionately larger technology staff, while being under-weighted with business-people.

FACTORS SHAPING THE OUTLOOK FOR THE SECTOR TO 2020

To assess the future of the technology sector in BC, trends and predictions, as difficult as making them may be, have to be taken into account.

The talent shortage will continue

Jurisdictions with the best ability to attract and retain talent will be able to grow their technology industries faster than others. BC will have to proactively use its assets like quality of life, education and cultural diversity, to be competitive.

Global competition will accelerate

Companies will have to be increasingly able and sophisticated both to compete abroad and to fend off foreign competitors in their own markets. BC has to take advantage of its proximity to the US and its West Coast high technology clusters as its prime export market, which will continue to serve as first export step for most emerging companies

Global economic interdependencies and networks will widen

The trend of an ever more interconnected world with complicated transnational networks will continue. Understanding these interdependencies will become more difficult and effects will get even more multiplied (e.g. 2007 financial crisis). Professional management will require new and better tools for monitoring and decision making, creating new opportunities particularly for BC's software companies in this space.

Global enterprises will further expand and consolidation will continue

Scale becomes increasingly important. Small companies with desirable IP will be the targets of intensified search for leading edge technologies by acquisitive global players. This will put even more pressure on BC's technology sector to grow large enough companies that can anchor the sector and become themselves consolidators.

The 21st century belongs to Asia

Given Asia's growth rates and increasing economic maturity the Asian markets will grow in importance for exports and significantly more Asian companies will become global competitors. For the foreseeable future and until IP protection measures have become effective in countries like China, the US will remain the key target export market for BC technology companies.

BC's future lies in exports

For BC's growth overall and its technology sector in particular, exports will become indispensable for growth and wealth creation. As domestic markets saturate and the scale pressures on companies mount, exporting will be essential. This will also allow the BC technology industry to better shield itself from the cyclical nature of the domestic industry with its significant natural resources component.

Clean Energy Technologies will rise to become a key growth industry

Environmental consciousness and the impact of global warming will drive the accelerated adoption of clean energy technologies. With energy cost rises and companies increasingly having to bear the full cost of pollution, new technologies will become economically competitive and have the potential to become the next growth catalyst for the technology industry, similar to the internet and mobile communications late in the 20th century. BC, as an early North American adopter of measures facilitating that transition, has the opportunity to grow a strong cluster of world class clean energy technology companies.

The aging of the population and retirement will accelerate

This trend will have big socio-economic impacts on pension systems, health care, talent availability and other areas. Some aspects, like the need for innovative health care solutions, will offer growth opportunities for BC's technology sector, others, like the retirement of skilled workers, will put additional pressures on companies to maintain growth with limited availability of talent.

The importance of cities will continue to grow

The technology industry is already concentrated in metropolitan areas and the technology workers, which make up the creative class, increasingly want to live and work in cities with access to all amenities and short commutes. This will put a lot of strain on cities like Vancouver, who as one of the most livable cities in the world has a competitive advantage, provided it can handle the infrastructure pressures appropriately.

THE CHANGING WORLD OF THE FUTURE AND OUR RESPONSES

- The scale and pace of worldwide technology markets will grow substantially. Further globalization will magnify everything, cycles will accelerate and management teams will have to build organizations that combine scale with flexibility.

The margin of errors for small companies that have one bet to place will be further reduced. The digital natives, our technology workers of the future, will be better equipped to deal with this environment of constant change that the outgoing generation is able to.

- Clean energy technologies could well become the next big growth driver for the industry.

- Small jurisdictions like BD will have to become expert exporters and have to offer their technology companies an optimal business environment for them to succeed and to attract the talent they need. In other words, our companies need a functioning and growing technology ecosystem in BC to succeed.

BUILDING A SUSTAINABLE COMPETITIVE TECHNOLOGY INDUSTRY ECOSYSTEM IN BC

Many elements are required to build a successful technology ecosystem in BC, but we believe that the critical areas of focus are the following five.

1. Grow a healthy structure of small, medium sized and large companies

The reasons for the lack of a sufficiently large number of medium sized companies (50-500 employees) are not entirely clear, but we believe that poor scalability (due to the large number of service oriented companies), lack of motivation to grow (due to sufficient financial success for the founders/managers) and lack of management expertise (lack of training and experience for entrepreneurial managers to manage larger companies) are key contributing factors.

BC has a vibrant entrepreneurial culture and many promising companies are being started continuously. Too often these small companies become acquisition targets before they can grow to medium size. The difficulty of accessing later stage financing and the small size of the sector that prevents consolidation from within, pose significant challenges. This results in this imbalanced industry structure with many small companies, but disproportionately few medium sized and large ones.

This imbalance is detrimental to growth and becomes self fulfilling. With only few medium sized companies the chances of growing one to a large sector anchor are greatly reduced. Export growth is difficult to achieve with most small companies lacking the organizational and financial strength and capacity to expand abroad. Finally, we can not grow a critical mass of managers that combine the full set of corporate skill sets, since small companies do not require corporate functions like finance, strategic planning and marketing, sales organization management etc. and large companies only require a limited number of managers in each functional area.

Measures that would help building a more balanced industry structure include improved access to late stage financing; training of small company executives; mentoring programs; tax incentives that encourage later exits; attracting management talent into growth companies; incentives for acquiring companies to maintain corporate functions in BC and enabling exporting (see next section)

2. Growing technology industry export revenues

Exports are critical for growth, for reducing the technology sectors dependence on the rest of the BC economy and are key to overall wealth creation by bringing fresh capital into the province. To achieve the industry's growth goals for 2020, the technology sector has to outgrow the rest of the economy significantly and only exports will allow it to do so.

As noted above a balanced industry structure will help to build exports, but unless we can enable small companies to become exporters, their ability to grow into medium size will be seriously hampered.

BCTIA and BCIC are taking measures to address this issue by developing programs that are mostly directed towards education and information. We believe that the solution will be found in initiatives like export training; export tool boxes; information repositories; cooperation programs with federal and provincial government agencies; targeted trade missions; knowledge exchange, and facilitation of export initiatives.

3. Focus on areas of strength

The technology sector is made of many subsectors. The concentration of such sub sectors in a limited geographical area can lead to a cluster. Clusters benefit from synergies that the concentration creates. Examples are the availability of a specialized pool of workers and specialized suppliers, cooperation with the research and innovation infrastructure, investor attention, local competition, exchange of best practices etc.

For small jurisdiction like BC that can not support the full breadth of the technology sector at world class levels, the emergence of world class clusters is very important. These can not be built from scratch but evolve from existing areas of strength.

There is good evidence that BC is home to five areas of strength: wireless communication, life sciences, clean energy technologies, new media and parts of ICT. To grow these areas into clusters, they each require excellence in research and innovation, the presence of large anchor companies, a pool of small and medium sized companies that share the same core technologies and investors that pay attention to this regional subsector.

Measures that will facilitate the growth of these sectors of excellence into clusters include tax measures favoring these subsectors; directing research and development funding specifically in these areas; the coordination of university efforts to create research and innovation centers of excellence; strong cooperation between academia and industry, particularly involving the anchor companies; the facilitation of early adoption of innovative local solutions and local government procurement; attracting relevant conferences and trade shows; focused trade missions and outreach, and focused industry research to provide the basis of proactive measures.

4. Governments play an important role

The private industry is the key engine for the technology sector, but government policies can have a significant positive impact, particularly if they leverage private initiatives and are enacted as part of a comprehensive strategy.

The BC government has taken many positive steps to support the growth of the technology sector, including fiscal measures lowering corporate and personal taxation levels, direct program funding, venture capital programs, removal of red tape and interprovincial trade barriers, and export development support.

However, BC competes with jurisdictions worldwide and their governments, having realized the importance of knowledge based industries, are taking equally supportive and in some cases more direct measures. This makes it even more important that government initiatives and policies are achieving the best possible results through coordination at all levels of government and with industry stakeholders. Ideally the structure and organization of policy and initiatives in this area becomes part of the accepted culture, providing a higher degree of clarity and predictability.

5. Building a world class education system

The availability of highly educated and skilled technology workers is critical for the success of our technology sector. Growing and replenishing the pool from within is key to its sustainability. To achieve success, we need a world class education system and a culture that values education as a top priority.

The k-12 school system lays the foundation. Kids need access to the best teaching and learning environment possible and require the mentoring and encouragement by teachers and parents alike to pursue post secondary education, particularly in science and engineering. For this to work, schools need to be sufficiently staffed with well trained, motivated teachers that have access to the best teaching tools available.

Whereas K-12 lays the foundation, the post secondary institutions are at the center of the knowledge based economy. BC's universities and colleges not only train future technology workers, but are also a key source of innovation and are critical for BC's international reputation in research and innovation.

British Columbia is well positioned with strong research universities, but by focusing and coordinating the efforts we will be able to develop within individual universities or in cooperative institutes, centers of excellence that are truly world class. Such centers of excellence attract world leading researchers and teachers, who in turn attract the best students and the funds necessary to conduct ground breaking research.

Building such a system requires a considerable societal, corporate and ultimately political will. It will only happen if we can build a culture in which technology careers are highly regarded and considered cool, where corporations re-invest in the system and the government has the support to make the necessary investments and policy decisions.

Having largely developed within the past 40 years, the technology sector in BC is relatively young compared to BC's traditional industries such as mining, forestry, transportation and tourism. However, it has grown substantially to the point where it has a noticeable and increasingly significant impact on BC's economy.

The BC technology industry has largely developed to support BC's primary industries. Technology companies have emerged through the commercialization of innovation from universities and other research organizations, including corporations such as the former BC Tel.

BC has developed a number of strengths that make the province a fertile jurisdiction for the technology industry, and well positioned even in global comparisons. First and foremost is the strength of BC's talented technology community. The combination and concentration of universities, successful anchor companies, a strong entrepreneurial base and an excellent pool of skilled talent provide a strong foundation for the growing technology sector in BC.

Also, BC's west coast alignment provides access to a large, English-speaking, international market within the same time zone, and also offers proximity to global technology leaders in Washington, Oregon and California (including Silicon Valley) for investment and go-to-market opportunities.

BC's Pacific Rim alignment through the West Coast Alliance and its large immigrant populations provide access to the rising markets of China and India, while also creating opportunities for outsourcing of low-value-add functions. In addition, the Asia-Pacific region increasingly serves as a source of highly talented immigrants. However, this Pacific Rim connection is still emerging and has not been tapped to its full potential yet.

BC's reputation as a great place to live, work and play (which has been recognized in a number of

publications, including Vancouver's rating by *The Economist* as the Most Livable City in the World) is of great value to the technology industry, helping us recruit mobile and talented young technologists. In an industry that relies on the skills and expertise of its workers, this lifestyle value cannot be overestimated.

TECHNOLOGY IN EVERY INDUSTRY

The first market for most sectors is the domestic one, and the technology industry is no exception. The technology sector plays a vital role in all of BC's domestic sectors. For example, IT infrastructure is at the core of every sector of the economy, including government, financial services and health care. Other technological areas such as clean energy and life sciences not only help to enrich the lives of all British Columbians, but are also big potential export sectors that can benefit from a sizable domestic market base

BC's primary industries rely on technology every day to increase productivity and enable new revenue streams to better exploit natural resources. Often these companies are themselves the source of new technologies, as well as spinning off additional new technology companies.

Technology has a big impact on health care delivery by reducing the cost of activities that are not patient-focused (such as administration), and by developing new treatments and procedures that improve patient outcomes and help people lead longer and better lives.

While BC's technology industry has made BC's primary industries more productive and successful, these primary industries have shaped the evolution of BC's technology sector as well, creating a number of specific strengths. For example, the diversity of BC's geography and our historic reliance on wireless

communications pushed BC companies to develop ruggedized hardware that can withstand the rigors of application in marine and other harsh environments.

BC's vast geography also encouraged our technology industry to develop expertise in easy-to-deploy self-contained systems, including independent power generation and storage and wireless communications. Similarly, the fact that the forestry sector generates 67% of its energy requirements from biomass has fostered expertise in bio-energy.

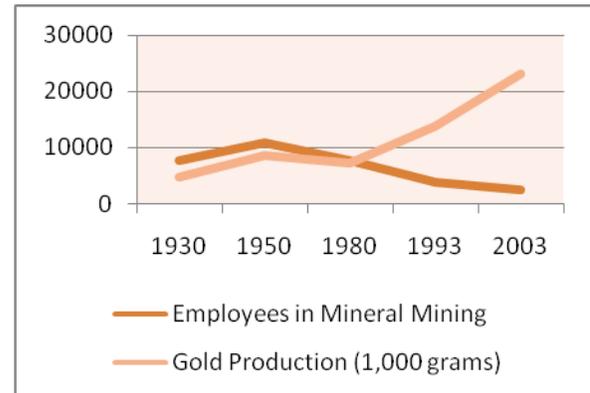
The roots of the technology sector naturally lie within the requirements of the domestic industries that were served first. Although the sector has evolved well beyond these beginnings, it remains inextricably linked to the rest of the economy, which remains its main market, particularly for the small, service-oriented companies that make up the bulk of the province's technology sector.

MINING AND TECHNOLOGY: AN EXAMPLE OF INCREASING PRODUCTIVITY

Supporting technological innovation brings significant benefits to BC's primary industries, increasing production capacity and worker safety while reducing the cost of production by enhancing process efficiencies. Figure 1 illustrates the dramatic increase in productivity achieved by BC's mining industry as a result of the incorporation of new technologies.

In 1930, the mining industry required more than three times as many employees to extract approximately one-fifth as much gold as was extracted in 2003. This trend has accelerated in recent years with the rapid evolution of new technologies. Gold production has tripled in BC since 1980, while the number of employees required to

extract and process it has decreased by more than two-thirds.¹



Although this chart depicts increased efficiency in gold production, this trend is representative of gains made by the entire mining industry as a result of technological progress. Similar trends can be found in forestry and agriculture.

EMERGING SECTORS OF EXCELLENCE

The province's leading universities have a reputation for developing a wide range of engineering and scientific talent, from electrical and mechanical engineering to computer science, advanced materials, photonics and life sciences.

The diversity of the talent pool in such a small geographic area facilitates cross-disciplinary innovation and enables researchers and companies to create a range of technologies that service almost every sector of the economy.

However, clusters of strength are emerging where companies complement each other with overlapping products and services, as well as similar market targets.

¹ All mining statistics obtained from the BC Ministry of Energy, Mines & Petroleum Resources website

Most notably, these clusters of strength are appearing in:

- Life sciences and biotechnology
- Digital media
- Clean energy technologies
- Wireless telecommunications
- ICT

Each of these sectors are building a base of anchor companies and a critical mass of entrepreneurial companies, and these concentrations of innovation are attracting global attention.

HISTORY OF THE BC TECHNOLOGY INDUSTRY

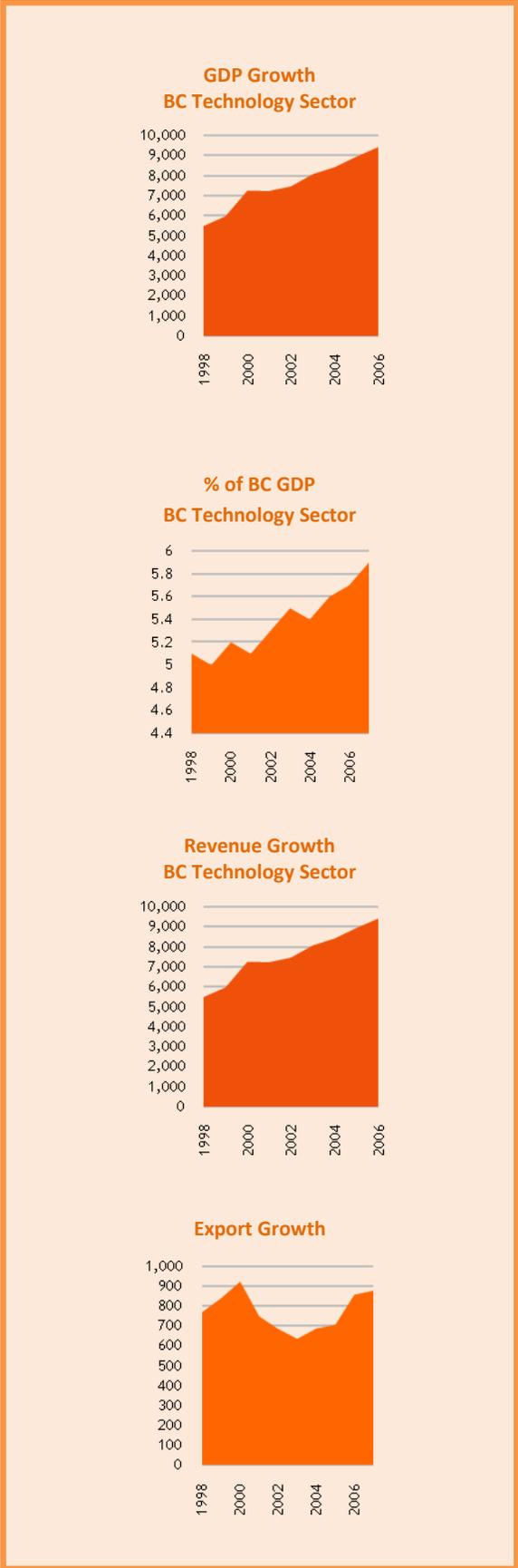
Much of BC's technology industry got its start developing products and services for domestic markets, particularly BC's primary industries including forestry, mining, transportation and the public sectors. With each new generation, BC companies have branched further into a greater array of industries and global markets. Meanwhile, new innovations from university labs and the basements and garages of BC's entrepreneurs have helped to create new market segments and clusters of technology companies to service those markets.

Several of BC's flagship advanced technology companies including Sierra Systems, MDA and the former Glenayre Electronics got their start in the 1960s. With assistance from the former MPR Teltech (the R&D arm of provincial telecom BC Tel) and companies such as ACCPAC in the late 1970s, BC developed strengths in hardware and software, and generated new areas of innovation such as the wireless sector that exists today. The software community has also been assisted by BC's proximity to Redmond, WA, home of global software giant, Microsoft Corporation.

The founding of Distinctive Software in 1981 and its subsequent acquisition by Electronic Arts in 1991 established BC's new media sector. The creation of a Vancouver-based studio by television mogul Stephen J. Cannell in 1987 further fuelled BC's complementary motion picture and TV production capacity.

The university lab has also been a source of innovation for BC's advanced technology sector. The spin-out of QLT from UBC provided the cornerstone for BC's burgeoning biotechnology and life sciences sector, which was further augmented by the spin-out of companies such as Angiotech, Cardiome and Neuromed.

The university lab also served as the inspiration for the 1979 founding of Ballard Power, whose global leadership in fuel cells has helped to create the fuel cell cluster in BC. British Columbia's technology industry has since developed a strength in clean energy technologies, with a number of additional spin-outs including Westport Innovations in 1994.



WELL-PAYING JOBS

Employment in the technology sector has increased by nearly two-thirds since 1991, and now exceeds the previous heights reached during the dot-com bubble in 2000 and 2001. With 81,140 employees and a total payroll that exceeded \$4 billion in 2007, the BC technology sector is becoming one of the largest employers in the province.

According to BC Stats, workers in high technology occupations earned an average of \$1,180 per week, compared to only \$760 for employees in all industries as a whole in 2007.² Additionally, with the exception of 2006 when the tight labour market for construction considerably inflated salaries in that sector, the technology industry has outpaced the rest of the economy in salary growth.

It is also important to note that the technology sector headcount does not include the thousands of technology workers that are “embedded” within the internal technology and IT groups of non-technology organizations such as governments, financial services companies and resource-based businesses. These companies often source their technical employees from the technology companies that serve them.

In 2007, those employed by BC’s high technology industry earned an average of \$1,100 per week, compared to the BC average of \$760 for all industries.

WEALTH CREATION

The technology sector not only creates high-paying jobs, it also generates significant wealth. Many BC founders and investors have benefited from their

² Schrier & Hallin, BC Stats and Leading Edge BC, 2008, *Profile of the British Columbia High Technology Sector*

successes, both through gains from acquisitions and profits derived from successful operations. More often than not, portions of these gains were re-invested in the sector through angel and venture capital funding.

Although start-up costs have historically been significant (particularly in a sector such as biotechnology, where R&D trials and approvals can often take 15 years and tens of millions of dollars), in most technology sectors, output is highly scalable. Often, the marginal cost of creating one more unit of output (such as one more piece of hardware or one more dose of medicine) is negligible. Therefore, once successfully launched and commercialized, new technology products enable the rapid growth of a technology company without necessarily requiring large amounts of capital to scale its operations. The export of these products brings new money into BC and creates additional wealth throughout the entire provincial economy.

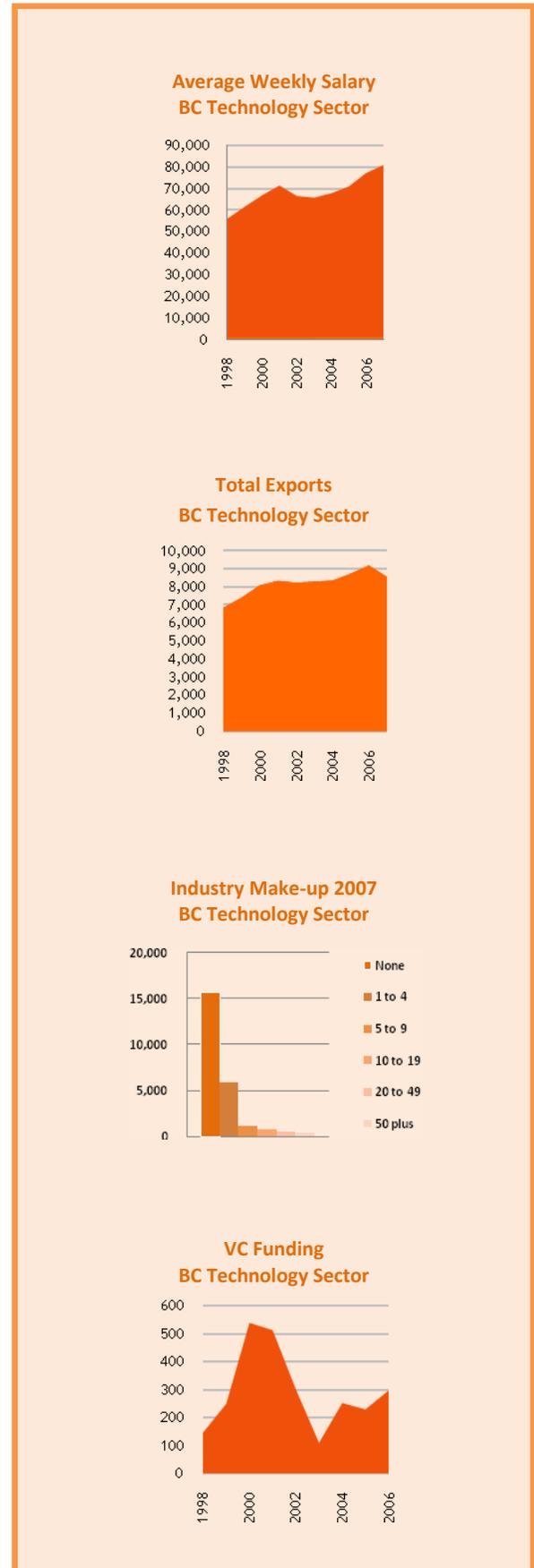
RISING GDP

In the past few years, BC’s high-tech industry has outpaced the overall economy in GDP growth, accounting for approximately 5.9% of GDP in 2007, up from 5.2% in 2006 and significantly higher than the 1.8% it generated in 1984. The technology sector will continue to play an increasing role in BC’s economy, delivering a growing percentage of provincial GDP.

LOW EXPORTS

While the BC technology sector produced \$18.1 billion in revenues in 2007, only \$2.7 billion of that revenue (18%) was derived from exports, with the remainder from the Canadian domestic market.

With technology empowering every industry, a considerable amount of the technology sector’s revenues will always be generated domestically. Because almost 94% of industry revenues come from



North America, the BC technology industry's success is highly correlated with the state of the general BC and North American economies.

While export revenues have more than doubled in the past 10 years, rising from \$1.45 billion in 1997 to the current level, BC's technology industries still export very little. Many of our companies lack the necessary export know-how to accelerate the growth of the sector. Arguably, BC's technology exports are somewhat undervalued, as many of the revenues generated by research and development in the province accrue to headquarters in other jurisdictions. Regardless, even in those situations, many of the desired export-oriented business functions are also outside of the Province in the same head office.

INDUSTRY OF SMALL COMPANIES

The technology industry in BC comprises mostly smaller companies. Of the 8,600 technology companies identified by BC Stats, 7,000 have fewer than 10 employees, with 5,800 having fewer than 5. Only 348 technology companies (of all descriptions) have more than 50 employees. In the *Business in*

Vancouver 2007 list of the top 100 technology companies in the province, the 100th-largest company identified had only 69 employees.

There are also more than 15,600 sole entrepreneurs actively consulting and contracting in the industry. Research from the BCTIA's 2007 TechTalentBC Labour Demand Study suggests that at least 80% of BC's sole entrepreneurs are truly independent, working for more than three clients each year.

The current industry structure does not allow the development of a sizeable pool of professional management with relevant experience in all aspects of corporate management. This situation, not only drastically limits the capacity necessary to build larger companies that need this type of management experience, but also makes the retention of experienced managers a challenge. As a result, the structural weakness of the tech industry gets perpetuated.

GOOD BREADTH OF TECHNOLOGIES SUPPORTED

BC has a strong university and college infrastructure, anchored by UBC, which is one of Canada's largest

BC'S TECHNOLOGY INDUSTRY IN PERSPECTIVE

On many economic development measures associated with technology, BC is typically ranked 3rd or 4th in Canada behind the much larger provinces of Ontario and Quebec and competing with comparatively sized Alberta. However, when BC is compared alongside individual States as well as Provinces, we often fall into the bottom half of the comparison.

With 4.3% of BC's workforce in technology jobs (4th place in Canada), we pale significantly in comparison to California (9.8%), Washington (9.5%), Massachusetts (9.4%) and even the US average of 5.9%. Admittedly, this is a national issue as much as it is a provincial issue. Even Quebec, our highest ranked province is only marginally above the US average at 6.3% of employees working in technology.

When comparing high-tech wages, while high-tech workers in BC earn \$1100 per week, a 44% premium above the average of \$760 for all workers in the province, but 33% less than the average American technology worker who earns \$1,657 per week. Again, this is a systemic national issue as much as it is a provincial issue. The average technology worker in the United States earns 87% more than the average worker across all industries.

Rationale for the lower wages has been blamed on the fact that BC tends to have smaller technology companies, who typically have fewer resources to pay top people. While the average US technology company has 16 employees, the average BC technology company has less than 10.

research universities. This infrastructure has strengths in engineering, health care and agriculture, and is supported by a number of research institutes, including the BC Cancer Agency and the Michael Smith Foundation for Health Research, as well as the Herzberg Institute of Astrophysics and the Institute for Fuel Cell Innovation (through the National Research Council Canada).

Other supportive research strengths can be found in BC Hydro's Powertech Labs and the TRIUMF National Laboratory for Particle and Nuclear Physics. In addition, the university system is fed by a public K-12 school system that delivers good results in science and math when compared internationally. Unfortunately, due to natural trends in population and preferences among young people, fewer higher-education students are choosing to specialize in math and sciences.

On a per capita basis, BC's technology industry is the fourth-largest in Canada, following the considerably larger provinces of Ontario and Quebec and closely competing with Alberta.

SOFTWARE- AND SERVICES-HEAVY

According to BC Stats, in 2007, approximately 91% of BC's technology companies were either services or software companies (BC Stats only differentiates between companies that manufacture goods and those that do not, which are classified as services).

Given the large number of very small companies in BC, it is safe to assume that the majority are service companies that provide IT, communications, engineering and other services to the rest of the industry (tech and non-tech). This impression is further validated by the fact that only 20% of revenues are generated by exports (i.e., generated internationally; revenues generated in Canada outside BC are not tracked separately).

These small services companies, which form the bulk of BC's technology community, generally have a

small number of clients, a limited geographical reach and are very difficult to scale given that their main input is labour.

CONCERNS OF SCALE AND FOR SCALABILITY

Although the breadth of the technology industry in BC provides it with the flexibility to accommodate sector trends and fluctuations, its relatively small size in comparison to other global technology jurisdictions does not provide for a lot of depth in any one particular sector. As a result, the technology industry in BC can be considered to be a mile wide and an inch deep.

The lack of scalability within several of the sectors results in a number of things including:

- **An inability to bid on large sales.** Large projects often require large teams to deliver them and the scale of many projects is too great for many BC companies;
- **Social insulation** created by a limited commonality between individual companies that minimizes individual interactions and synergies.
- **An inability to hire Highly Qualified Personnel (HQP)** from other jurisdictions as they see little other opportunity should their job not work out;
- **Difficulty to scale successful companies** due to a lack of qualified people with domain experience. This is most evident within senior management positions in BC.

The service orientation of many BC companies is also a cause for concern. For service companies, labour output is very closely correlated with revenue output. Therefore, growing revenues in service-oriented companies requires considerable scaling of human resources (if they can even be found) with little economies of scale benefit when compared to companies with productized solutions. Due to the

cost of labour inputs, organizations need to sell at a premium against productized solutions in the same market.

An example of this scalability issue is in IT companies that service the forestry industry. Previously small IT companies have been able to generate a comfortable income selling custom software and services to local mills. However, industry consolidation has tended to displace custom technology as the consolidators tend to standardize operations on their existing IT infrastructure.

To compete, many of these companies are repackaging their domain expertise into productized solutions that can be more easily sold to forestry industries around the world.

To compete, BC companies need to make a cultural shift toward productizing their domain knowledge so economies of scale can be achieved.

In line with this cultural shift, BC companies need to better appreciate the importance of product management and marketing functions in growing their businesses. Governments can play a role by incenting companies to shift from custom and service-oriented solutions to more productized offerings.

KEY ISSUE: ACCESS TO CAPITAL

BC has been relatively successful in developing programs for encouraging angel investment in start-up companies. Specifically, the Small Business Venture Capital Act, with its support for Eligible Business Corporations and Venture Capital Corporations, has been very successful and is regularly over-subscribed. However, although BC has been successful in developing its angel investment networks, the province lacks sufficiently large pools of capital for later-stage financing. Many BC start-ups sell out before reaching the critical mass required to grow independently, and difficulty accessing capital may be one of the key reasons

Without sufficient support at each stage of a company's evolution, its growth will be limited and it will seek to be acquired. As a result, the industry has difficulty maturing and developing a healthier structure. The BC technology sector lacks a mature hierarchy, instead comprising a small number of

large companies, a middle bloc of medium-sized companies and a base of many small companies.

After the acquisition of smaller companies, R&D often stays in BC, but these companies typically do not provide the opportunity to build other classes of skills such as sales and marketing, business systems and general senior management. Government measures, such as the BC Renaissance Fund, are targeting this issue by introducing new venture capital funds and players to BC. While this initiative shows signs of promise, it is too early to tell if it will have a sustainable impact.

KEY ISSUE: ACCESS TO TALENT

One serious challenge that BC's technology industry faces is a significant shortage of skilled technology workers and senior technology management talent. The 2007 TechTalentBC Labour Demand Study undertaken by the BCTIA found that the industry expected to create 10,000 new jobs in 2007 and 2008 (with the likely addition of 5,000 net new jobs during the period).

The demand for new talent is considerably higher than the output of BC's postsecondary institutions. Therefore, one of the important ways to meet this demand is to recruit talent from other jurisdictions.

It is critical to create initiatives and programs to develop, recruit and retain talent, and to use available instruments, such as the Provincial Nominee Program, that facilitate and accelerate the immigration of needed talent.

The attraction of executive talent from outside BC has proven particularly difficult. Candidates often lack alternative employment options if the position they immigrate to fill does not work out (end-of-the-road syndrome). Also, compensation levels are not on par with other jurisdictions, given that the cost of living and the tight housing market remain issues for immigrating talent, including executives.

KEY ISSUE: GOVERNMENT POLICY AND TAXATION BARRIERS

There are certain aspects of policy and taxation that act as barriers to the success of BC's technology industry. Although considerable progress has been made toward creating a business-friendly and investment-friendly climate in the province, there are a number of additional changes that could be made to attract business and investment, and to streamline commercialization processes. It is imperative that going forward all levels of government continue to build a friendlier environment that encourages entrepreneurship and attracts foreign investors.

Over the past eight years, the provincial government has made significant strides toward improving BC's business-friendliness. These changes have allowed the industry to recover from the technology bubble and to grow to its current strength, particularly in light of economic factors such as the rapid appreciation of the Canadian dollar.

Changes that the government has brought to the technology industry include:

- Improved access to capital, including larger annual investments in the Small Business Venture Capital Act, as well as the introduction of the Innovative Clean Energy (ICE) Fund and the BC Bioenergy Network to help prove out new clean energy technologies, and the BC Renaissance Fund to attract additional venture capital to BC
- Reductions in personal and corporate income taxes to make BC one of the lowest-taxed jurisdictions in Canada and thus an attractive place to locate people and companies
- Improvements to the labour legislation to reflect the knowledge worker economy
- Strengthening the Provincial Nominee Program to expedite the entry of highly skilled foreign workers
- Maintaining a provincial focus on climate change, which will create a more attractive

environment to live and work while developing new business opportunities for

BC's green technology companies

KEY ISSUE: LACK OF DEFINING PLACE

One way in which the various levels of government can build the knowledge economy is by helping to create a place that will be a focal point for the economic sector. Focused places encourage like-minded companies to locate together, while also serving as a nucleus for attracting knowledge workers. Innovations occur and synergies are created when people bump into each other and start sharing ideas and knowledge.

The most notable place in the global technology industry is Silicon Valley, which over the past 60 years has grown out of much smaller focused places including the Research Park at Stanford University and the community around the famous Xerox Parc campus in Palo Alto.

These places can arise organically, as has happened to some extent with the Yaletown and Railway technology neighbourhoods in Vancouver. However, to get the full benefit of collaboration and synergies, partnerships between industry, academia and government are essential in establishing formal

research parks. In 1979, the vision of then Minister of Education Pat McGeer's led to the Province endowing land for Discovery Parks in Burnaby.

The technology parks built as a result of this endowment are full today, as is the Vancouver Island Technology Park now owned by the University of Victoria.

With escalating commercial real estate costs, companies are scattering across the region. While this scattering is fine for established companies, start-ups need not only affordable space, but also access to services, proximity of mentors and idea exchange with companies facing similar challenges.

Concentrating start-ups in technology parks not only creates synergies, but also creates lighthouses for the industry that attract attention and energy.

Projects like the Great Northern Way offer unique opportunities and have to be developed strategically and with broad support.

COMPARISON: BC VS. OREGON

While jurisdictional comparisons are always difficult due to the variance in underlying resources, populations and political climates, the State of Oregon is a relatively good comparator for BC. BC and Oregon have similar west coast alignments and both have historically relied on natural resources to provide many of its jobs and wealth.

While Oregon has the advantage of being sandwiched between the technology centres of Seattle and the Silicon Valley, the cultural diversity of the lower mainland arguably provides us a more cosmopolitan edge for attracting global talent.

Although Oregon has a slightly smaller population (3.5 million inhabitants vs. BC's 4.3 million), the two jurisdictions do have similar-sized technology workforces (Oregon: 83,986; BC 81,140). The greatest differences are in how those workforces are comprised. While BC reports approximately 8,600 technology establishments, Oregon reports only 4,700, creating an average company size nearly twice that of BC's. Similarly, Oregon's technology workers are better paid than those in BC. In Oregon, the average technology worker earns \$75,600 USD compared to \$57,200 CAD in BC.

Oregon is significantly more reliant on the hardware industry than BC is, with over 44,000 employees (53% of its workforce) in high-tech manufacturing. In comparison, BC has approximately one-third as many jobs (14,600) in its high-tech manufacturing sector. With off-shoring continuing to increase, this reliance on manufacturing jobs leaves Oregon considerably more exposed to cheaper jurisdictions than BC.

Oregon is also continuing to diversify its technology industry. It's balance of lifestyle, affordable living, and proximity to Seattle and the Silicon Valley make Portland a great city for many software developers to create businesses. As a result of these emerging high-potential software companies, Venture Capital investment in Oregon grew by 97% in 2007 to \$302million US. This figure compares well to the \$316 million CAD of Venture Capital invested in BC in the same year, a growth of 6% over 2006. BC has traditionally be much stronger than Oregon in attracting Venture Capital.

While BC has focused on tax incentives for R&D and investment activities, many of Oregon's tax incentives are based on property-tax and income-tax relief, particularly when locating or starting-up in designated 'Enterprise Zones'. Oregon also issues tax-exempt bonds on behalf of qualified businesses to provide affordable interest rates for long-term debt financing for land, buildings and other fixed assets. Given the capital-intensive nature of many of Oregon's high-tech employers, these are all very important incentives for attracting businesses and jobs.

While Oregon has not been as successful as BC in transferring technology from its universities, the state is working to improve this innovation channel. In October 2007, the State of Oregon introduced the University Venture Development Fund to assist with the funding of technology transfer projects at eight Oregon universities. The state has authorized up to \$14 million in tax credit-eligible gifts. Oregon residents who donate to the fund are eligible for a 60% state tax credit.

Like BC, Oregon is also turning to alternative energy technologies as a key component of its future. With continual advancements in semi-conductor manufacturing required new and better manufacturing facilities, and a continuing off-shoring of manufacturing jobs, Oregon is now courting photovoltaic manufacturers to replace many of the jobs, facilities, and investment being left behind. Oregon has also created Rural Renewable Energy Development (RRED) Zones to encourage investments in wind, geothermal, solar, biomass, ocean waves and other unconventional forms of energy in non-urban centres.

The BC Technology industry has been studied in a number of capacities over the past several years by the Premier's Technology Council, the Competition Council and the Integrated Technology Initiative (ITI), a cross-industry project that encompassed all of BC's technology sectors and included nearly 200 participants. These studies have produced a plethora of recommendations on the most effective ways to increase access to talent, capital and markets, as well as improving processes to encourage new innovations and facilitate their successful commercialization.

A key ITI finding was that BC lags behind comparable North American jurisdictions in R&D expenditures, as well as public and private investment. Funding for industrial and academic R&D is relatively low, which limits our ability to develop and commercialize new technologies.

In 2007, many of the recommendations derived from industry studies were synthesized into actionable projects through the Provincial Technology Strategy, which comprises five pillars:

- **Capital** – Financial support and resources
- **Commercialization** – Innovation pipeline, R&D investment
- **Culture** – Infrastructure and general willingness to support the technology sector
- **Markets** – Market access and alliances, creating a brand for BC's technology sector
- **People** – Development of local talent and recruitment of international HQPs.

Although these issues have been addressed through a variety of initiatives by a number of different organizations, the strategy has not led to a concerted approach.

The Provincial Technology Strategy is strong on recommendations but lacks clear economic goals in the context of the overall economy – an issue addressed in this paper. However, there is a consensus that the five pillars are essential for the growth of the industry, and their importance is elaborated upon in the sections that follow.

THE ADVANCED TECHNOLOGY ECOSYSTEM

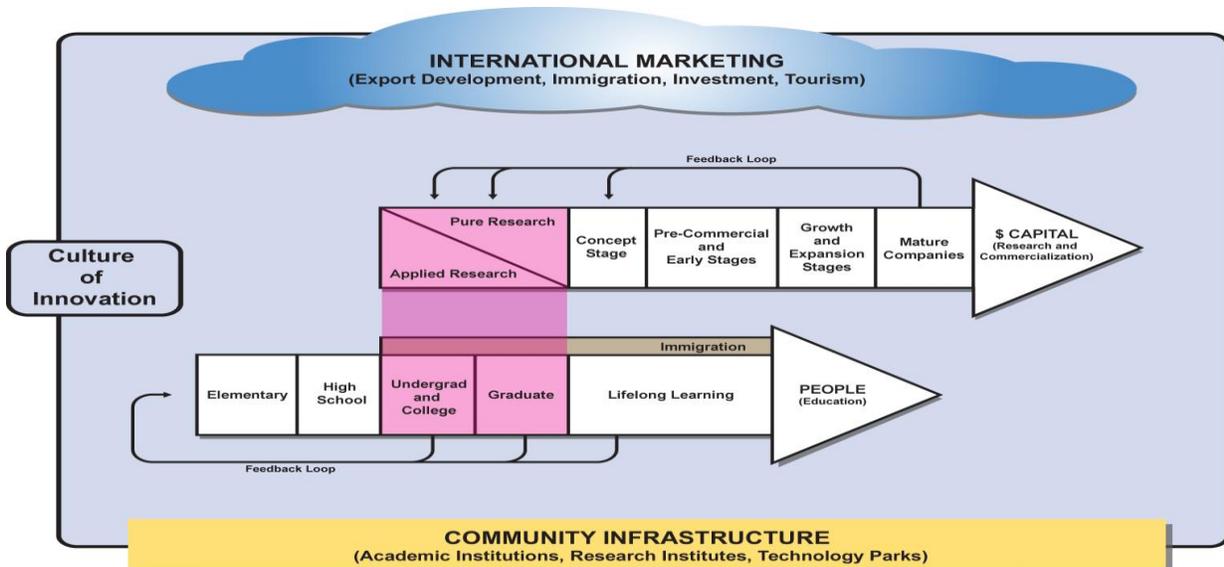
The technology business cycle is fundamentally simple: Innovation → Product Development → Commercialization → Revenue and Profit Generation → Re-investment into New Technologies.



For this process to be successful and repetitive, it takes five elements, which have been extensively researched, validated and described in the Provincial Technology Strategy put forward by the ITI in 2007:

- Capital
- Commercialization
- Culture
- Markets
- People

Each of these pillars is necessary for a strong technology sector. The real key to success, however, lies in having a system in place in which each of these elements is interacting in a way that continuously strengthens the system and re-enforces the processes within it. This creates the sort of snowball effect that facilitated the growth of technology sector powerhouses such as the Silicon Valley.



THE INNOVATION ECOSYSTEM

While the BC technology strategy refers to the five essential components of a successful technology community as pillars, these components are not

isolated from one another, and should be considered part of a symbiotic Innovation Ecosystem. It is only when all parts are working in balance that true sustainable growth can occur.

The Innovation Ecosystem relies on the following ingredients:

- **A Strong Talent Pipeline** – Encouraging science and technology from K-12 to graduate research and lifelong learning, and having an efficient immigration system that attracts and helps integrate highly-skilled workers
- **A Strong Capital Pipeline** – Ensuring adequate resources, particularly funding, for companies at all stages of their commercialization life cycle – from pure and applied research to concepts, pre-commercial companies, and ultimately mature technologies and companies
- **A Culture of Innovation** – Supporting innovation in such a way that these pipelines create feedback loops where each generation of people and companies feeds into the next

The Talent and Capital pipelines are both systematic and linear, and as such, require attention at all stages. Each stage relies on the one before it, so problems at one stage subsequently become problems for a later stage as well. Also, an over-focus of resources at any one stage can have an impact on other stages.

Underlying the Innovation Ecosystem is the community infrastructure that supports the innovation economy, including academic institutions and research institutes, as well as catalytic infrastructure such as technology parks and programs for encouraging research, development and successful commercialization.

Assisting the Innovation Ecosystem in its wealth-building efforts are international marketing efforts undertaken by the community and by governments to introduce BC companies abroad, and to encourage foreign investment and the immigration of skilled workers.

THE IMPORTANCE OF FEEDBACK LOOPS

To create a true ecosystem, the key pipelines of Capital and Talent need to create feedback loops where the success of one generation of commercialization helps to feed subsequent generations. Successful feedback loops include:

- **Wealth Creation** – Proceeds from acquisitions or exits are reinvested in the creation of a new generation of startups.
- **Mature Management** – Mature management exit successful companies to move on to new organizations, bringing their management expertise with them.
- **Research Sponsorship** – Mature companies sponsor research at leading universities, fostering the continual development of technology leaders and new technology opportunities.
- **Cooperative Education and Internship** – Companies are hiring up-and-coming talent to augment their education and introduce new ideas into the organization.
- **Mentorship** – The community encourages science and technology among K-12 students and mentors young technologists and aspiring corporate executives. As parents and grandparents of the next generation of scientists and technologists, community members have a vested interest in the development of the next generation.

The objective of the Innovation Ecosystem is to achieve a balance of components that will encourage the feedback loops to create a runaway effect, increasing the strength of the feedback with each cycle.

A well-functioning Innovation System has:

- **A Healthy mix of companies**, including anchors, emerging anchors and start-ups – a solid pipeline of companies at all stages of the life cycle
- **Companies increasing in size and age** to some equilibrium point where growth is maximized, yet innovation is still occurring
- **Increasing headcounts in key business functions**, such as Product Management, Marketing and Sales to maintain a balance between technologists and business line staff
- **Maturing management**, where the average length of experience in the industry is growing, but there is still a healthy inflow of new managers
- **Continually increasing exports and GDP**, driving new wealth for the province and for Canada

EXAMPLE: BUILDING A TECHNOLOGY CLUSTER – MASSACHUSETTS

Starting from an area of strength in the life sciences that is very similar to conditions in BC today, Massachusetts has developed one of the world's pre-eminent life sciences clusters. The cluster consists of top tier academic and research organizations, pools of scientific talent, several successful SME's and the attractive living conditions of the Boston area. The life sciences sector in Massachusetts today employs 77,000 people at an average wage of \$80,000 and supports one in seven jobs in the state.

To achieve this the Commonwealth of Massachusetts took a strategic approach and combined programs providing financial benefits to research institutions and companies who were working on innovative new products and research. The Job Creation Incentive Payments, the Emerging Technology Fund, the Massachusetts Life Science Fund, the Cooperative Research Solicitation and the New Faculty Strategy Solicitation, and other programs combined with fiscal measures like the Economic Development Incentive Program and Single Sales Tax Treatment created a robust innovation-driven environment.

These efforts are on-going and emulated elsewhere: in the past 18 months the State has committed \$3B in funding over the next ten years to the sector and 40 other US states have followed suit with programs that help to attract and retain talent in the life sciences.

Using similar strategies, there is no reason why BC cannot build an equally successful, globally competitive and sustainable life sciences sector.

To assess the future of the advanced technology sector in BC, trends and predictions must be taken into account. However, predictions are tricky and trends tend to be nonlinear.

While some trends can be validated by hard facts (for example, we know that lower enrollments in K-12 schooling today will lead to less university enrollment in years to come), others, such as the exchange rate on the Canadian dollar (which has a great impact on the net revenue that the technology sector brings to BC), are highly speculative. The focus here is on the more predictable trends.

GLOBAL ECONOMIC INTERDEPENDENCIES AND NETWORKS

The global financial crisis that began in 2007 illustrates how connected the world economy has become. Vast amounts of capital are flowing across borders, goods and services are sourced globally, and large corporations and banks affect many different jurisdictions. Domestic economies are inextricably linked to one another.

Globalization has made economic systems much more complex. Interdependencies are increasingly difficult to understand. This not only makes assessment of the potential impact of interventions in the system harder, but also forces a much higher level of international cooperation by regulators. National institutions such as the U.S. Federal Reserve need the support of other central banks and must coordinate their efforts. The recent financial crisis has demonstrated that economic intervention has become a transnational issue.

If such global network effects and trends multiply very quickly, the economic picture will continue to be subject to large, fast changes. This requires a higher level of adaptability, not only for governments, but also for individual companies.

Implications: *Risks and opportunities arise quickly. This not only requires high-quality management and*

leadership, but also the tools that allow speed and flexibility in all aspects of operations – from decision making to development, manufacturing, sales and finance. The technology industry in BC can benefit from a growing demand for such tools by following the old adage that the only constant is change.

GLOBAL COMPETITION WILL ACCELERATE

The technology sector operates in two fundamental markets: domestic and exports. As technology is a tool for most businesses and much human activity, a large proportion of technology companies, particularly in the ICT sector, serve local organizations and households.

While some of these products and services are being delivered by global enterprises (e.g., IBM providing IT services and products), competition is regional or even local. Small players and sole entrepreneurs form the majority of market participants and their growth correlates with the overall level of economic activity in the province.

Export-oriented technology businesses create wealth by generating revenues outside BC and retaining the gains within the province. They are tapping into global opportunities, but are also exposed to global competition. Emerging markets such as China and India will offer tremendous growth potential for export-oriented companies, but as their education systems become stronger and their capital markets mature, new companies will emerge and add to the number of globally active businesses, initially with very competitive cost structures that allow them to make up for a possibly lower level of technological sophistication by throwing much more technical personnel at the challenges. An example of this trend is the emergence of Huawei and ZTE as global telecom equipment suppliers that today go head to head with companies like Nortel and Alcatel-Lucent that were previously dominant in this market.

Implications: *Global competition will increase in the years to come, and companies will need to be more*

sophisticated to meet these competitive challenges. They must defend their domestic markets from new external competitors, as well as being proactive in growing new markets. BC should take full advantage of the proximity of the U.S. market as its prime export destination, which often serves as a first step for companies going global.

CONSOLIDATION AND THE IMPORTANCE OF GLOBAL ENTERPRISES WILL CONTINUE

Global expansion of enterprises has been tremendously facilitated by modern transportation, IT, communication, and the opening of global trade and capital flows. This is particularly true for technology companies. IP is transportable, and long-distance cooperation and networked, geographically distributed teams have become mainstream. In their efforts to become more competitive and innovative, global companies are scouring the world to find critical pieces of IP, technologies and products to improve their portfolios. We believe that this trend will continue, particularly with new companies coming from emerging markets and looking for footholds in more established economies.

Implications: *Entrepreneurial companies with desirable IP and technologies will become even more attractive targets for acquisitive companies. This will increase the temptation for early exits and make it more difficult to find the patient capital required for building medium-sized and large entities that retain full corporate capabilities (R&D, sales and marketing, finance and general management) after an acquisition (i.e., Creo at the time of its acquisition by Kodak) instead of being converted to regional R&D centres that report to distant corporate centres. This trend will also make the need for solid anchor companies more pronounced, if BC is to develop a strong sector that is built to last.*

THE 21ST CENTURY BELONGS TO ASIA

At the heart of the increasing global competition is a shift in international balance. Where the 20th century saw the transition of economic dominance from Europe to the USA, the 21st century is likely to see the transition from the USA to Asia, particularly China and India.

The populations of China and India collectively outnumber Europe and the U.S. three-fold, and their economies are outgrowing those of Europe and the U.S. by a factor of four. According to *The Economist*, China intends to spend a higher percentage of its GDP on R&D than the European Union by 2020. India already produces more engineering graduates annually than the U.S. and by 2015, China's researchers and scientists are expected to outnumber those of any other country.

Meanwhile, the level of political and economic sophistication of the Asian markets is rising rapidly. This growth and stability is creating a tremendous market both for the country's domestic consumption and its foreign imports.

Today, only 11% of BC's technology exports go to Asia, of which Japan absorbs 7%.

Implications: *China and India will not only become more formidable competitors, but also offer sizeable market opportunities for BC companies. We cannot expect Asia to overtake the U.S. as our main export market, but we can anticipate a major increase in exports in the years to come, with Asia becoming the destination for closer to 25% of our exports. However, while Asia's markets mature and issues such as IP protection get addressed over time, the U.S. will remain our key export market and thus deserves our full attention.*

EXPORTS ARE BECOMING CRITICAL

BC's technology sector, particularly ICT, has grown largely based on domestic demand driven by strong overall economic growth since 2001. With the proliferation of PCs and Internet use in the late 80s and early 90s, the growth of technology demand was driven by a continuously increasing adoption of ICT technologies by all industries. However, this demand is now more incremental. New technologies and products have to find a larger market than the domestic one to justify development costs. Thus, exports are critical for innovation and growth.

***Implications:** A stronger export orientation will allow the advanced technology sector to immunize itself to some extent against the cyclicalities typically associated with an economy that has a strong natural resources component. It is also critical for the continued growth of the technology sector as domestic markets approach a level of saturation that prevents the industry from growing faster than the rest of the economy.*

CLEAN TECH WILL BECOME A KEY SECTOR

Environmental consciousness and greenhouse gas reduction initiatives are likely here to stay. The introduction of carbon tax and cap-and-trade systems in environmentally conscious jurisdictions not only makes those places more expensive for polluting industries to do business, but should simultaneously create a cleaner environment and green culture that is more attractive to a highly educated work force.

Should global warming accelerate to the extent that flooding of low-level areas, extreme weather patterns, large-scale agricultural disruptions or widespread droughts affect daily life on a global scale, the issue of an environmental catastrophe could become one of national security. This would change economic paradigms, with the cost of emissions rising dramatically. The adoption of alternative energy sources would accelerate, and investments in such sources would increase sharply, with potentially big impacts on the global economy.

We can expect the entire clean energy technology sector to grow dramatically once the cost of carbon emissions and other pollutants is economically priced and becomes an integral part of costing. This will make the adoption clean energy technologies not just a nice thing to do, but an economic necessity. This shift could be as seminal for our industry as was the emergence of the Internet in the 90s and the proliferation of mobile communications thereafter, which both led to big growth spurts for the technology industry. In other words, clean tech could be the next big thing.

***Implications:** This focus shift not only opens new opportunities for the clean energy technology sector, but also for the technology industry overall as innovative IT solutions, improved manufacturing technologies, and more effective logistics and communications can all contribute to lower carbon footprints.*

Many jurisdictions will seek to attract clean industries such as advanced technologies to offset the potential loss of industries with high carbon footprints, and we can expect the competition for such companies to increase. This may be reflected in additional tax incentives and other fiscal measures, including subsidies for clean industries.

Companies located in jurisdictions that are early adopters of this changing paradigm will benefit if their domestic markets not only embrace the trend, but also offer resources for commercialization, suitable demonstration sites with minimal red tape, and early implementation opportunities through government procurement approaches that favour domestic solutions.

IMPACTS OF AGING POPULATION AND RETIREMENT WILL DEEPEN

Canada's aging population and increasing rate of retirement will have multiple effects on the advanced technology sector between now and 2020.

The retirement of the Baby Boomers will further strain the tight job market and deprive the sector of experience and management capabilities. While this changing of the guard will also create accelerated career opportunities for younger workers and draw more people into the industry, overall the loss of experience and mentors will likely be more significant, and thus have greater negative effects.

The aging population will also increase the pressure on the pension and health care systems. Unless major changes are made to health care, both in operational effectiveness and funding, the government will be forced to continually allocate more of its budget to health care, to the detriment of other activities such as education and economic development.

Implications: *To counteract rising health care costs, governments will have to seek technological solutions, more prevention and early detection, and possibly new economic models for funding. From a workforce perspective, the advanced technology sector will have to find ways to reduce the negative impacts of an aging workforce by convincing potential retirees to remain professionally active beyond the traditional retirement age. Supporting measures would include flexible work hours, increased time off and extended health benefits.*

THE TALENT SHORTAGE WILL CONTINUE

The technology sector is facing an overall talent shortage, which expresses itself in two ways:

- The number of technology workers available is too low.
- There is a shortage of certain skills within the available talent pool.

Predicting the shortage in numbers is pretty straightforward, given the declining K-12 enrollment in BC, the identified requirement of 10,000 technology jobs in the province in 2008 and the growing rate of retirement in an aging population.

Even under a no-growth scenario, the talent shortage is likely to worsen.

Immigration will increase as a result of both push and pull effects. While globalization has opened up economies and markets, it has also made immigration easier and more accessible, particularly for well-educated workers with transportable skills. These knowledge workers will increasingly pursue opportunities for better lifestyles and careers globally. At the same time, the talent shortage will also create pull effects as technology companies search for talent globally. Skills requirements are changing over time and harder to assess. However, the trend of a growing shortage of sales, product management and project management personnel is likely to persist. As companies mature and launch and commercialize more products, the need for these functions will increase, with no indications of more supply on the horizon. This trend may be alleviated by attracting a higher percentage of new students into technical disciplines, as well as increasing immigration and extending the work life of future retirees, but these measures will not be sufficient to avoid a tight labour market for the advanced technology sector.

Implications: *An increasingly tight global market for talent will make it difficult to grow the industry as jurisdictions compete for the same people. Openness to immigration, both socially and legally, will become increasingly critical. Those jurisdictions with the ability to attract and retain talent will be the ones best positioned to lead global markets. In this tightening market, BC has to proactively attract and retain talent by building on its assets, including quality of life, good educational infrastructure and multiculturalism.*

DIGITAL NATIVES ARE EMERGING

Between 2010 and 2020, digital natives (people who have grown up with computers, the Internet, broadband wireless services, and all the products and applications connected to digital technologies)

will reach the age at which they become key decision makers in our society. Their predecessors had to learn how to use and take advantage of these technologies, displacing the way they did business in the past. For digital natives this is all innate. They don't know the world without digital technologies and they have learned effortlessly how to use them while growing up.

This new generation, referred to as the Baby Boom Echo, Gen Y or the Millennial Generation, communicates differently, absorbs information easily and processes it in a different way to make decisions. They have a different set of expectations and they are very information-literate. As such, they tend to be more cynical and distrusting of information that is fed to them. Also, they expect an environment in which they collaborate to shape the decision-making process.

These tendencies will likely lead to an overall acceleration of cycles: Information will be disseminated faster, decisions will be made quicker and products will come and go in short time spans. As a consequence, innovation cycles, product development cycles, sales cycles, product life cycles, etc. will all be shorter. This will require market participants to be more nimble, take advantage of short windows of opportunity and maximize returns over a shorter time period.

For a jurisdiction to remain competitive in such an accelerated world, the public sector will have to adapt as well. Regulations, policies and government decisions will have to keep pace with the rest of society, and while the public sector decision makers will also be digital natives, the processes within which they operate may have to be overhauled in order to be effective.

Implications: *The technology industry and its workforce are at the forefront of the digital native trend. Other sectors will follow and learn from the experiences of the technology sector, which will in turn take a leadership role in the adjustment process that businesses will have to go through.*

Governments will need to work with the technology

sector to understand the impact of these social changes and adapt its own way of doing business accordingly.

CITY STATES WILL GROW IN IMPORTANCE

Knowledge-based industries thrive in high-concentration areas. There are always exceptions to the rule, but advanced technology businesses tend to be established close to one another, where they have access to talent, proximity to one or more postsecondary institutions and the services infrastructure they require (lawyers, accountants, auditors, etc.). They are also inclined to locate in areas with easy access to national and international transportation. In short, they concentrate in larger cities or agglomerations. This is well illustrated in BC, where 68% of all technology companies are located in the Lower Mainland, 6% on Vancouver Island, 8% in Thompson Okanagan and the rest across the province.

Another key factor that reinforces this trend is the growing attraction to cities of the so-called creative class that includes technology workers. These people want choice in employment, career options and lifestyle. They want to minimize their commutes (out of convenience and environmental consciousness), and to have access to vibrant sports and cultural offerings, retail shopping and entertainment.

Implications: *The continued trend toward global cities creates issues for cities that have to manage growth in their residential, commercial and transportation infrastructure without becoming unaffordable. Greater Vancouver is well positioned to provide a lifestyle that is attractive to global talent if the province continues to build an environment that fosters the growth of successful businesses, and the various cities can coordinate regional growth to ensure affordability.*

THE CHANGING WORLD: OUR RESPONSE

Combining the trends outlined in the previous section allows us to draw a high-level picture of the world in which our technology industry will operate in the future. The scale and pace of the worldwide technology markets will grow substantially. Furthermore, globalization will magnify everything: competition, scarcity of talent, opportunities, the number of large global players, and the pace at which companies emerge and disappear.

Management will face continuous change and operate in a culturally shifting business world with the growing influence of Asian market participants. Massive, continually growing amounts of information will be available in near or real time and will have to be processed quickly to allow fast decision making.

The faster pace will accelerate business cycles, and windows of opportunity will open and close quickly. Organizations will not only have to be very sophisticated and nimble, but also have the ability to change direction and invest resources quickly, which will favour large but flexible companies. Small players will not have much margin for error in such an environment.

The next decade could see another technology revolution similar to the Internet revolution, or a proliferation of wireless communications once clean energy technologies are adopted on a large scale.

A new class of technology workers will emerge, and these digital natives will be much better equipped to deal with a fast-paced environment flooded with information than the Baby Boomers who will exit the labour market.

Economies like BC, with their very small domestic markets, will have to become experts at exporting. Our companies will need world-class managers who can operate internationally and build larger companies that are able to attract highly qualified personnel, ideally locally, but also globally.

Overall, BC's technology companies will need an ideal business environment in which to operate. In other words, for our technology industry to succeed in the global markets of the future, we need a functioning, growing and self-propelling Technology Ecosystem.

BUILDING THE TECHNOLOGY ECOSYSTEM IN BC

To successfully build, maintain, strengthen and expand the Technology Ecosystem in British Columbia, we have to:

1. **Grow a healthy structure of small, medium-sized and large companies** so that the ecosystem can attain long-term sustainability, with a particular focus on increasing the number of medium-sized companies.
2. **Grow export revenues and the number of exporting companies** to accelerate revenue

growth and increase the independence of those revenues from the rest of BC's economy.

3. **Focus on areas of strength** and make these areas stronger in order to succeed in the face of global competition.
4. **Implement strong public sector structures and processes** that allow the government to optimally facilitate the growth of the advanced technology sector.

5. **Establish a world-class education system and a culture of educational excellence** to grow the pool of highly talented technology workers and foster an environment of innovation and creativity.

BUILDING A HEALTHY INDUSTRY STRUCTURE

With the relatively small size of BC's technology companies, the province lacks a significant base of emerging anchors – those companies likely to become the next generation of anchor companies for the industry. Although there has not been sufficient research conducted to generate a definitive answer as to why BC lacks medium-sized technology companies with 100 to 500 employees, there are a number of possible reasons:

1. **Poor Scalability** – As the majority of BC's technology companies are service-related businesses with labour as their main input and their reach limited by geography, their ability to scale is low.
2. **Acceptable Financial Performance** – Despite their small size, many BC technology companies are financially successful. Their founders and owners (who are mostly the main revenue generators for the firms) earn good incomes, thereby providing little incentive for significant growth.
3. **Minimal Management Expertise** – In line with the relative success of many of the founders, the majority of technology entrepreneurs have had little exposure to formal management training in finance, sales and marketing, strategic planning and general management. Operating companies with a few employees is within their ability. However, growing their businesses, raising money, hiring large numbers of new people, formalizing plans and managing their companies through levels of management

will often push them out of their comfort zones, as well as presenting a risk to the income and lifestyle their company affords them. As such, many of these entrepreneurs have little motivation to expand.

BC has a history of vibrant entrepreneurialism. From traditional industries such as forestry and mining to technology, pioneering entrepreneurs have fueled our economy. And when their companies emerge as promising or successful firms, they become attractive takeover targets, regardless of the industry they are in. Being acquired is an appealing option for founders and investors who are looking for an exit to realize the capital gains on their initial investments, instead of taking the risk of expanding the company further to potentially make higher gains in the future.

The companies that have the highest chance of succeeding are also the ones that are most likely to attract acquirers. Many of the entrepreneurs that sold their companies in their emerging state went on to found new ones, but only a few have grown their companies into medium-sized or large organizations that have remained headquartered in BC or were not taken over until they had achieved maturity.

In larger jurisdictions, consolidation from within can be the means by which bigger companies emerge. BC's technology sector has always lacked the scale to have a sufficient number of acquirers and targets to allow for consolidation. Although some consolidation did take place during the "tech bubble" years when capital was abundant and technology companies engaged in a land-grab-type bonanza, this was not sustainable once things returned to normal.

This imbalanced industry structure has three major impacts that significantly limit the growth of the sector:

- **A Lack of New Anchor Companies** – In the absence of medium-sized companies, the number of larger anchor companies does

not grow, and the ones that disappear for one reason or another will not be replaced. We are, in essence, missing the nursery from which to grow larger companies.

Anchor companies play a crucial role in training the next generation of managers, investing back into the community, and conducting both private research and cooperative research and development with local universities. Large anchor companies are critical for industry growth, and most emerge from a pool of medium-sized companies.

- **Underperformance in Exports** – Small companies of fewer than 50 employees have a hard time exporting. They generally lack the financial and organizational strength to tackle international markets.

Not having the ability to export seriously limits the scope of these companies and curtails their growth prospects. The lack of medium-sized technology companies is probably one of the reasons for the low technology sector export figures in BC.

- **Underdevelopment of Complete Management Sets** – Only large and medium-sized companies require the full corporate managerial skill set. Finance, strategic marketing, management of sales organizations, business and management information systems, and other managerial skills are generally not required for small businesses.

Large companies only need one CFO, CIO or VP of Sales. In the absence of medium-sized companies, BC does not have the ability to grow the required managerial talent, which becomes a vicious cycle: New managers aren't trained or attracted, while the ones looking for work have a hard time finding suitable positions and may end up leaving.

This lack of a formidable mid-tier of companies is not an easy problem to solve, but this is not a good reason to ignore it. To create wealth, money has to flow into the province. For our industry, this means either attracting investments or, more importantly, increasing exports. We need the balanced industry structure not only to create a healthy ecosystem for the technology industry, but also to create wealth from this key industry sector going forward.

To present detailed solutions would exceed the scope of this paper, and a lot more analytical work will be required to determine root causes and effective remedial actions. However, we can offer a few suggestions:

- **Improve access to later-stage financing** from VCs and private equity funds, as well as ensuring easier (less costly) ways to access public markets to reduce capital barriers that impede the growth of smaller companies.
- **Ensure that small business fiscal incentives** lead to the creation of such businesses without incenting businesses to remain small.
- **Train small company executives** to provide them with the necessary skills to grow their companies beyond their current comfort zones.
- **Offer mentoring programs** to help small company executives implement effective strategies to grow their companies.
- **Introduce tax incentives that encourage later exits** and provide rewards to founders and investors for selling their companies at a later stage, such as lower tax rates on gains from later-stage exits.
- **Attract better management talent** through incentives that encourage experienced executives to join smaller companies with a

growth mandate – such as minimal or no taxation of stock option gains after a certain hold period.

- **Create export-enabling initiatives** to help smaller companies become exporters (this will be discussed in detail in the next section).

GROWING INDUSTRY EXPORT REVENUES

BC's technology sector only generates 20% of its revenues through exports. However, exports are important for three reasons:

- They allow decoupling of the technology industry's revenues from the prevailing economic climate in the province (making it more of a bellwether).
- They bring fresh money into the province.
- They support increased growth.

With the majority of our technology companies servicing the rest of the economy, their revenues will fluctuate based on the economic climate within the province. Overall, the BC economy is still highly dependent on traditional sectors such as natural resources and construction, and is therefore subject to the cyclicity of these sectors.

In recent years the technology industry has greatly benefitted from strong economic growth in British Columbia, growth that is now slowing in BC and the rest of North America. As such, the technology companies relying solely on domestic revenues will feel the impact. Exporters will be able to mitigate some of these effects, particularly those that have tapped into emerging markets such as Asia that continue to grow at a much stronger pace.

Bringing fresh money into the province is the key to wealth creation. A dollar that circulates within the province remains the same dollar, even if it registers as revenue after each transaction. For fresh money to come in we either have to attract foreign capital, have visitors come to BC and spend money earned abroad here, or export goods and services.

The domestic market in BC is of limited size. Our technology companies are facing a saturated, mature market that grows slowly, and they have to share it with foreign competition. In other words, there is a limit to how many technology products and services can be sold in BC. To sustain a growth rate that exceeds overall economic growth, our technology companies must generate revenues abroad.

The benefits of export-fueled growth are substantial. Using the current industry average revenue per employee of approximately \$200,000, every additional \$1B in exports equates to 5,000 new jobs.

The technology sector's ability to export requires a more balanced industry structure. As we get more medium-sized companies, the ability to export expands, and as our smaller companies become able to export more, they grow into medium-sized ones.

Enabling smaller companies to become exporters will facilitate the development of more mid-sized companies. As such, generating more revenues by tapping into a much larger global market is the best way for our small companies to grow beyond their current scope.

The BCTIA, in cooperation with the British Columbia Innovation Council (BCIC), is taking a proactive approach to the issue of export growth. Many of BC's small technology companies produce exportable products or services (including software) that are underexploited.

We are currently working to identify those companies with export potential – particularly those that either export little today or have an exportable product or service that isn't being exported.

The next step in the BCTIA's process is to develop programs that will enable these companies to become exporters.

Program elements should include:

- Executive training
- Export tool boxes

- Information repositories
- Cooperation programs with federal and provincial government agencies
- Targeted trade missions
- Knowledge exchange
- Facilitation of export initiatives
- Investors attracted to a specific industry sector can concentrate on a limited geographic area.
- Local competition creates additional impetus to excel.
- Networks among related companies emerge.

FOCUS ON AREAS OF STRENGTH

The advanced technology industry is a heterogeneous sector that consists of multiple sub-sectors. While the fundamental premise – converting innovation and intellectual property into revenues and profits – holds for all sectors within the technology industry, the underlying technologies, development and commercialization processes, markets, customers, products and business models vary.

According to Harvard Business School strategy guru Michael Porter, once related industry sectors concentrate in a geographical area, a cluster is created. This applies to all industries, not just technology and innovation sectors. BC, for example, has a strong forestry cluster that combines companies that harvest trees, those that process them into lumber and others that use the residues for pulp and paper production, as well as a whole range of services that feed off that industry, ranging from surveying to transportation.

The benefits of clusters result from the synergies created by the concentration:

- Employees move across companies and bring with them experience and best practices.
- Career paths become industry-wide and are not company-limited.
- Suppliers and service providers become specialized in servicing the needs of the cluster.
- Universities and other research and education institutions produce the graduates the cluster requires and benefit from academia-industry cooperation.

Overall the cluster of businesses results in a concentration of specialized people and specific IP.

These cluster benefits are obvious, and Porter cites numerous examples of clusters worldwide, which have generally emerged and grown organically over time. Creating a cluster from scratch would be a stretch, but facilitating and nurturing an emerging cluster makes sense.

A small jurisdiction such as BC cannot become a world-leading technology hub that includes a large variety of sectors. We can, however, become world class or at least very competitive in certain areas, and we don't have to start from scratch.

Before looking at areas that may already be or have the potential to become clusters, we need to examine the elements and characteristics that make a cluster possible. For the technology industry, four elements must be present:

1. **Excellence in research and innovation**, both in universities and institutes and within existing companies in cluster-relevant sciences and technologies
2. **Anchor companies or large enterprises that operate internationally** and hold a leading position in the market segments that cluster companies would target
3. **An ecosystem of small and medium-sized companies** that share core technologies and other attributes within a cluster
4. **Investors who pay attention to the sector** represented by the cluster and provide an adequate stream of funding

The strength of a cluster is determined by the degree to which these elements are present within a geographical area. British Columbia is home to a number of technology industry sectors that have the potential to emerge as clusters, including:

- Wireless
- Life sciences
- Clean energy technologies
- New media
- Parts of ICT

Assessing the strength of each of these sectors and validating in detail their cluster potential would exceed the scope of this paper, and needs to be further researched in the future. However, each of these sectors:

- Has demonstrated good entrepreneurial engagement and access to funding
- Includes strong anchor companies
- Has technological areas of interest that are well represented in BC's universities and research institutions

These elements are present in different degrees for each of these sectors, but they all have some of the characteristics required to become clusters. In addition, BC is home to some industry-wide anchors, such as MDA and Kodak Imaging Systems, which transcend individual sectors.

The key is not necessarily to qualify these sectors as clusters, but to recognize them as areas of excellence that have a much better chance of becoming clusters if properly nurtured than other sectors would. Focusing on these areas of excellence is critical for BC to become world-leading in some sectors of the technology industry. This can be achieved by:

- Developing a formal cluster strategy
- Proactively and Strategically Attracting anchor companies
- Expanding tax measures favouring these sectors

- Increase the extent to which research and development funds are directed specifically into areas and projects relevant to these sectors
- Working with the university system to coordinate efforts, and making sure that excellence is achieved through cooperation (pooling university resources in specialized institutes and facilities that become global centres of excellence)
- Reaching out to anchor companies and securing their support for achieving research excellence in these sectors
- Eliminating red tape that jeopardizes early adoption and using procurement policies to support innovative local solutions
- Attracting relevant conferences and trade shows
- Focusing trade missions and other outreach activities on these sectors
- Concentrating industry research on these sectors to collect more relevant statistical data and conduct better analyses

ENABLE GOVERNMENT TO PLAY THE IMPORTANT ROLE IT HAS

The ecosystem model helps us to understand the complexity facing government when developing policies and initiatives for the advanced technology sector. The government's tools and capacity to advance the interests of an industry sector such as advanced technology are limited. Private enterprise, therefore, is the key engine for the technology industry.

However, policies affecting taxes, education, research and innovation funding, procurement and other factors can have a significant positive impact on the growth of the technology industry. Government measures are particularly effective when they:

- Complement one another

- Leverage federal and private initiatives and funding
- Affect durable fundamentals
- Are part of an overall strategy

This approach can be further supported by organizational structures and processes that establish ownership and accountabilities in line with medium to long-term views.

The BC government has already taken positive steps and created initiatives to support the growth of the advanced technology sector. Fiscal measures such as lowering the corporate tax burden for companies that have reached the stage of revenue and profit generation allow them to re-invest in the innovation cycle and support their ongoing competitiveness. The reduction of personal income tax rates has also helped to attract talent.

Direct project funding through sources such as the Innovative Clean Energy Fund encourage the use of innovative technologies and support higher-risk development stages that are difficult to finance conventionally. Export development support such as market intelligence provided by market representatives, trade commissioners and government-led or sponsored trade missions can facilitate exports into new markets.

Governments worldwide are recognizing the importance of knowledge-based industries to their futures, and are implementing policies and providing funding accordingly. Approaches include direct funding, subsidies, fiscal measures, procurement policies and many others. While these policies may not all be appropriate for British Columbia, they do shape the competitive environment in which Canada and BC operate. International policies and initiatives must, therefore, be reviewed regularly, with the goals of identifying actions that could be adopted by the provincial government and ensuring that the provincial government remains aware of competitive advancements in other jurisdictions.

As the Technology Ecosystem continues to expand and evolve, its growing complexity will require an

ever more sophisticated ability to evaluate, support and promote those opportunities to ensure that BC's technology industry is well-positioned to make the greatest contribution to our overall success. To this end, sector participants and government must continuously improve the integration and oversight of all policy decisions that affect the technology industry. These encompass marketing and the development of infrastructure, skills, talent and financial support instruments. Ideally, the structure and organization of policy and initiatives will become part of the accepted culture, providing a greater degree of certainty and predictability. All parties should work together to establish processes of decision making that are transparent and supported in the context of the overall provincial economy.

CREATING A WORLD-CLASS EDUCATION SYSTEM

The importance of education has been recognized for quite some time. Former BC Liberal cabinet member and world-renowned professor and Alzheimer's researcher Pat McGeer, in his 1972 book *Politics in Paradise*, quotes from a report issued by John Macdonald, then President of UBC, in 1963:

Though we are blessed with a host of physical attributes for a healthy economy, the key to competition and growth is the condition of the human resource. Do we have the wisdom, imagination, determination and courage to plot an educational course which will ensure our position in the front ranks?

The growing importance of knowledge-based industries within our overall economy makes the availability of highly educated and skilled technology workers a key competitive differentiator. To succeed, British Columbia needs to build a global reputation for its education system, and its pool of skilled knowledge workers fed by this system.

Every jurisdiction faces its own challenges in educating, attracting and retaining talent, and BC is no exception. We may be outperformed by competing jurisdictions, particularly those south of

the border, in terms of cost of living, housing availability and compensation levels, but we are world-leading in quality of life and cultural diversity, have made considerable progress in personal taxation levels, have taken positive steps to facilitate immigration and, thanks to a growing technology industry, offer a larger variety of lucrative career options.

BC has received considerable federal investment, notably through the establishment of federal centers of excellence. This is a testimony to our research capacity, but it also mandates us to make sure we capitalize on these investments.

The shortage of talent remains a growth inhibitor. As such, attracting talent from outside BC will remain important, but the key to a sustainable talent pool will be growing and replenishing it from within.

Success requires two fundamentals: a world-class education system and a culture that fosters and values education as a top priority. The K-12 school system lays the foundation. Students must have access to highly qualified teachers who are equipped with the latest teaching tools available. These teachers must operate within a network of schools that are safe havens for learning, regardless of regional and socioeconomic differences. However, children's interest in pursuing higher education is not influenced by school alone. Their parents and the environment in which they grow up are just as important, if not more so.

With enrollment in K-12 dropping due to demographic changes, it will become increasingly important to encourage more students to make the transition to postsecondary education and graduate studies in general, and to specialize in areas such as math, science and engineering in particular.

For the system to work, schools must also be staffed by a sufficient number of well-trained and motivated teachers whose compensation is in line with their academic training. This will be a necessity for the future of our technology companies, and for the economic future of our children and their families,

given the shift in our economy and the growing share of knowledge-based occupations in the job market.

Whereas the primary and secondary school systems provide the foundation for a well-educated pool of technology workers, the postsecondary institutions are at the centre of a knowledge-based economy. Not only do colleges and universities train future technology workers, they are also a key source of innovation and renewal. British Columbia is well-positioned with strong research universities.

For BC to be known as a competitive knowledge-based economy and jurisdiction, we need a world-class postsecondary education system overall, but also individual institutions that have global reputations as leaders in teaching and research. Not every university can achieve a top ranking, but by focusing on areas of strength, every postsecondary school should aspire to be world class in a chosen field. This will attract top talent for the faculties, as well as research funding from both public and private sources to fuel innovation. It will also attract the quality and quantity of students required to enhance the global reputations of their alma maters and provide the technology sector with highly qualified workers.

Whether or not we can achieve this institutional level of excellence in our education system will depend on the societal, political and corporate will to make this a priority. Only if parents motivate their children, and being educated and interested in technology and other knowledge-based professions is considered worthwhile and cool, will kids chose that path.

Corporations also have to invest in and make continuous learning part of their cultures, as well as investing in the postsecondary education system. Investment does not necessarily mean donation, but should include co-operative research projects, student co-op programs, research funding, participation in curriculum design and more involvement overall.

Once society is on board, it is much easier for governments to mobilize the political will and consensus to make education a high priority, and to invest in it consistently and predictably.

Knowledge-based industries, including the advanced technology sector, are the key to our economic

future. As such, we must invest in the system which generates the human resources that fuel those industries. This transformation will take time, but the sooner we start, the better we will be equipped to face the global competition.

REALIZING THE LONG-TERM GOALS

Between 1997 and 2007, the technology sector in BC doubled in terms of GDP and revenues. Overall, the technology sector's share of BC's GDP rose from 4.9% to 5.9%. In addition, the number of technology workers in the province grew by 43% and productivity (as measured by revenue per employee) increased by 40%. Exports as a percentage of revenues rose from 17% to 19.5%.

The performance of BC's technology sector between 1997 and 2007 was superior to that of Ontario, Quebec and Alberta. However, BC still ranks behind Ontario, Quebec and Alberta in terms of per-capita contribution to GDP, revenues and employees. Also, 28 U.S. states have a higher GDP per capita generated by their technology sectors than does BC. Oregon, for example, generates 15% of its GDP from its technology sector.

As part of the Opportunities BC 2020 initiatives, we have established the following goals for the BC technology sector in 2020:

- Transform the industry's structure to include anchor companies for each relevant sub-sector, with 10% of the technology companies having 50 or more employees
- Triple the size of the technology sector size in terms of GDP to \$30B
- Increase revenues generated by the sector to \$50B
- Increase the number of technology sector employees by 75% to 142,000
- Grow exports to 35% of the sector's revenues or \$17.5B

Taken in isolation, these goals may appear ambitious. However, considering that with this growth our technology industry would still only contribute 8.5% of our overall GDP, these goals are not farfetched. Rather, they represent a threshold we must cross to make the successful transition to a more knowledge-based economy.

In the previous section we outlined the five elements of a strategy that will enable us to achieve these goals. Each of these elements will require detailed implementation approaches. Some of the strategies apply to the technology industry as a whole, whereas others may need to be customized for application to particular sub-sectors. For example, the requirement for strong public sector structures and processes applies to the entire sector, whereas the measures directed at building a healthy industry structure will depend on the maturity of the sub-sectors. If we are to be successful, all stakeholders will need to work hard on initiatives and policies that will facilitate the achievement of the specified growth targets.

The cornerstone for achieving the growth targets will be the health and balance of our industry structure. We need a strong segment of medium-sized companies (with 50 or more employees) for the technology industry to kick into a higher growth gear. Once companies have achieved medium size, they are in a position to engage in a continuous cycle of innovation, commercialization and revenue generation, with cash flows that allow them to

sustain the process and provide attractive returns to shareholders.

Companies need critical mass and scale in R&D, product management, marketing and sales to sustain their growth. This is very difficult to achieve with revenues below \$10M annually – unless firms are able to attract large amounts of investment on the promise of explosive growth in the future. Medium-sized companies not only form the pool from which large anchor companies can emerge, but their emergence in larger numbers will also create the snowball effect of growth – re-investable net income, growth financing, a growing number of professional managers and ultimately, a vibrant ecosystem that will attract new talent and capital, and fuel growth even further.

The type of growth desired will require expanded market access. Some companies may find a large enough domestic market to grow to \$10M in revenues and beyond. Most, however, will have to reach out and become exporters, in many cases by selling into the U.S. Enabling small companies to become exporters (or very strong domestic sellers) is the single most important catalyst for the growth of medium-sized companies.

Another key element to successfully achieving our targets is a world-class education system, which will be required to transform BC's economic focus from natural resources to human resources. We need an ever-increasing flow of highly educated and talented graduates to grow our companies both in size and sophistication. Through our research universities and institutions, this system will also enhance our innovation capacity and outcomes, which are essential for maintaining a stream of new entrepreneurial start-ups.

In pursuing achievement of our stated objectives, we must recognize that our investment capacity is limited. We must therefore focus our attention on areas with the highest probability of success and global competitiveness, those in which we have existing strengths that we can build on. This means investing selectively in some areas and not others.

To create an optimal business climate in which sectors of strength will grow stronger, whereas sectors in which BC has limited strength and/or potential will not absorb resources unnecessarily, we must:

- Consistently promote growing sectors and companies.
- Invest in research and innovation that not only excels in international comparisons but also supports the same successful sectors.

We have made significant progress over the past 10 years. The BC government has taken many steps in the right direction, including lowering personal and corporate taxes, offering larger tax incentives for venture and angel investments, growing funds dedicated to the education system and the research and innovation infrastructure, facilitating immigration and bringing down interprovincial trade barriers. However, achieving the goals specified in this paper will require a continued and enhanced effort from all stakeholders.

We must learn from other jurisdictions, as well as developing BC-based approaches to driving the growth of the sector. Given the structural changes occurring worldwide, including the ongoing shift of manufacturing employment to the developing world, achievement of the goals set out in this paper is critical if BC is to have a prosperous future.

CONCLUSION

British Columbia's economic future and wealth depends on our collective will and ability to transform our economy into a diversified, export-oriented growth engine. Traditional industries, particularly the natural resources sectors, have laid BC's economic foundation over the past 150 years. However, they will not be the source of growth that will allow us to maintain and expand our standard of living in the coming decades. Knowledge-based industries in general and the technology industry in particular, must become the key drivers of exports and growth.

BC has all the characteristics required to become a technology powerhouse. Global trends, such as the transition to clean energy technologies, offer incredible opportunities for growth, and we are well positioned to capitalize on those. However, we have traditionally lacked the collective urgency to decrease our economic dependence on the wealth of our natural resources. Other jurisdictions worldwide that never had this luxury are leading the way in the transformation of their economies to high-value-add knowledge-based activities, and we cannot afford to sit on the sidelines any longer.

We hope that this paper contributes to the discussion and helps to generate the creative energy that will drive BC's economic transformation and development. We did not attempt to develop a laundry list of specific action items or demands. Instead, we are putting forward considerations that should provide the strategic framework and background on which detailed initiatives and policies for achieving the specified goals can be developed. We hope that this report will contribute to an enhanced understanding of our industry and its critical importance to the province in the years to come, and provide the foundation for developing an aggressive strategy and action plan going forward.

All stakeholders in British Columbia have to bring their capabilities, influence and energy together and commit to BC's economy becoming knowledge-based in line with leading economies globally. This commitment needs to come from the industry itself, the provincial ministries, the Premier's Technology Council, the BC Innovation Council, the technology industry associations, as well as other business and community leaders across all sectors. We all bear the responsibility to make sure that British Columbia is not only one of the best places in the world to live, but also to work, invest and thrive.