JOBS AND GROWTH IN THE KNOWLEDGE-BASED ECONOMY

Background Paper for the Information Highway Advisory Council

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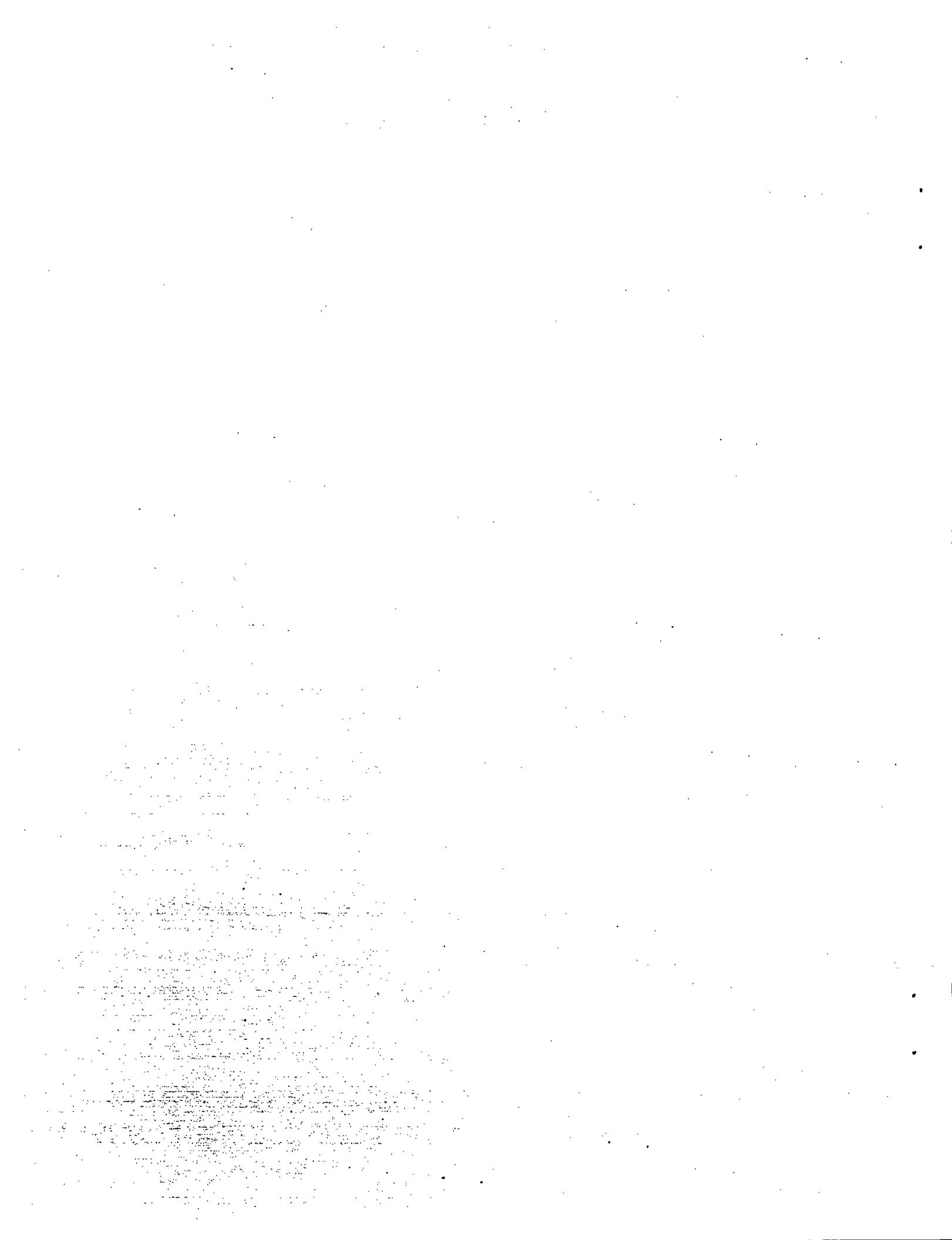

PREFACE

This paper addresses issues found at the intersection of two fundamental concerns to Canadians: the impact of the Information Highway on Canadian society, and the need to create a healthy economy that will generate jobs for Canadians. To address the first issue, in the Spring of 1994 the Minister of Industry established the Information Highway Advisory Council (IHAC) to provide the government with advice on fifteen key questions.

The second issue, the status of Canada's economy, is a principal public policy concern, and one of the Council's three original objectives was "creating jobs through innovation and investment in Canada." Two of the working groups established in this first phase of Council's work, one on Research and Development, Applications and Market Development and another on Competitiveness and Job Creation, developed the recommendations on economic issues for the Council's Final Report of September 1995.

The Final Report highlights the Council's beliefs that the Information Highway is central to creating a knowledge-based economy in Canada and essential to Canada's success in the global marketplace. The Report endorses the core principles that "Canada's success on the Information Highway depends on whether we can establish a competitive framework that unleashes creativity, innovation and growth," that "the private sector should build and operate the Information Highway," and that the "primary role of the government should be to set the ground rules and to act as a model to inspire Canadians." These principles are supported by specific recommendations in the area of competition, convergence, Canadian ownership, and the regulatory and policy framework. Recommendations on changes in the workplace address the imbalance between those looking for work and the growing shortage of skilled workers, by advocating the need to increase training opportunities and create a culture of lifelong learning. (In addition to the analysis and proposals contained in the Final Report, one member of IHAC issued a Minority Report, arguing against the subordination of government to the marketplace on economic issues, particularly in the area of employment and workplace issues.)

In the Spring of 1996, the Government released a plan of action in response to the IHAC's recommendations, *Building the Information Society: Moving Canada Into the 21st Century*, which reaffirms the government's commitment to establish a competitive environment as the most effective way to build the Information Highway. This document outlines a number of current and planned initiatives to foster economic growth on the Information Highway. To assist in implementation of this action plan, the Minister of Industry asked the Council to reconvene to address several outstanding issues remaining from Phase I of the its work and identified in *Building the Information Society*. For this second phase of work, the Council has organized five Steering Committees: Canadian Content and Cultural Identity; Access; the Internet; Workplace Issues and Lifelong Learning; and Economic Growth and Job Creation. While economic growth and job creation are pertinent to all of these areas, the latter two Steering Committees focus specifically on two dimensions of the employment issue.

The Steering Committee on Workplace Issues and Lifelong Learning is assessing the impacts of information technology on the nature of work, such as: the creation of the contingent workforce; ongoing changes in demands for new skill sets; and the rise of telework and other novel working arrangements and conditions. The Economic Growth and Job Creation Steering Committee has divided its work between micro and macro issues. Under its micro work, the Steering Committee is looking at three separate areas -- health, education and learning technologies, and electronic commerce and small and medium-sized business -- to assess the impact and potential of the Information Highway, emphasizing how government can promote job creation and economic growth. At the macro level, the Steering Committee's work focuses on the impact of information technology and the Information Highway on overall employment levels, and reviews strategies to address issues related to job creation. It is in response to this second area that this paper has been drafted.

EXECUTIVE SUMMARY

The Information Highway heralds profound technological and social change, challenging society to revisit fundamental assumptions about how our economy will function. Canada must adapt to these technological changes at the same time as it reacts to other powerful forces. Growing economies of scale for key products and ongoing trade liberalization are creating a global economy, while public and international institutions are reacting to limited funding by redefining their roles and responsibilities. Even understanding the more narrowly defined economic issues raised by the Information Highway requires a judicious sifting of current developments, economic theory, and historical precedents.

One of the most prominent aspects of the Information Highway is the accelerating stream of new technologies, products and services being offered. Nowhere is this more apparent than in the rise and growth of the Internet. Once a relatively obscure tool for the research and education community, it is now a global mass medium that many see as the core element of the Information Highway. Network technologies develop apace, with new connection services through cable, wireless, and upgraded telephone system protocols such as ISDN and ADSL. Computers continue to evolve at a dramatic pace, and the newest PC's have integrated design principles from consumer electronics. Each successive generation of portable computer is becoming more powerful: laptops have comparable power to standard desktops; personal digital assistants (PDAs) are increasingly popular, offering improved handwriting and voice recognition, network integration, and more power.

Many see the combined effect of all these new products, services and means of production as part of a fundamental transformation to a new economy based on knowledge and information. Parallels are drawn with the industrial revolution, where a rural and agricultural economy was displaced by one that was urban and based on manufacturing. If we are undergoing an equally profound shift, then we must try to assess its direction and implications.

Three economic aspects of a knowledge-based economy should be highlighted. The first is that the essence of modern economic growth lies in innovation. There is higher quality of life today not because we simply have more of what our ancestors possessed, such as foodstuffs, clothing and basic shelter, but because we consume new and better things and have superior ways of producing them. The second is that in a knowledge-based economy, ideas and information effectively overshadow physical goods and services as the primary units of production, distribution and consumption -- and ideas and information are considered nonrival goods with very different economic properties than rival goods such as bread, chairs and haircuts. Finally, the unusual economic nature of innovation and nonrival goods, such as the fact they exhibit increasing rather than decreasing returns to scale, means we have more work to do in order to fully understand how markets will produce and provide these goods and services. Prudence demands that as we move to position ourselves for maximum competitive advantage, we still try to

anticipate the full impacts of these economic transformations. This will involve revisiting our fundamental assumptions and thinking about the dynamics of a knowledge-based economy.

Despite the economic uncertainty highlighted by such considerations, it is clear that if Canada does not move quickly to create the products and services for the Information Highway, they will be created elsewhere, and Canadians will not reap the rewards of this new economic base. To date most jurisdictions, including Canada, have embraced the position that a dynamic, healthy, and competitive marketplace is a necessary condition for domestic economic success, and focussed policies accordingly. A quick survey of Canadian policies, including the work done in IHAC Phase I, as well as those of other jurisdictions such as the US, Europe and Asian economies, reveals a common concern for quick action to create a competitive market environment, but also to address issues such as R&D incentives, creating jobs through content development, and the need to develop public infrastructure in areas like health and education.

Having set in place policies to actively promote innovation and technological change, how successful have we been in gathering public support for this direction, and in delivering on the promises? Recent public opinion polls show that most Canadians support government measures to encourage information technology and the Information Highway: 88 percent of Canadians agree that "technology and information are the sectors of the economy where we're going to see the most growth". Several studies have found strong evidence that information technology is generating jobs and growth, and in fact there is a shortage of skilled people in key information technology areas.

However, the evidence is not all so optimistic. In a recent public opinion poll, 84 percent of Canadians agree that "as technology becomes more important in the economy, some people, and older workers in particular, are going to be left behind." In terms of employment studies, there is solid evidence that information technology is reducing employment in some industries, notably the manufacturing sector. A recent Statistics Canada' report "Industry Profile: Canada's Information Technology Sector" showed the industry's output grew an average of 8.1 percent a year between 1990 and 1995, pushing its share of gross domestic product from 5.5 percent to 7.6 percent. Total employment however, showed little growth, with the number of jobs falling from 316,459 in 1990 to 297,697 in 1993 before rebounding to 324,042 in 1995, reflecting an average compounded growth rate of only 0.5 percent over the five years.

These findings point to the need for further economic investigations to understand and deal with the impact of this technology. Indeed, Canada and other jurisdictions have identified specific economic policy issues arising with the Information Highway, and some are even exploring, or implementing, policy options to deal with them.

Two key policy challenges regarding the economic consequences of the Information Highway remain outstanding. The first is to complement the focus on creating a competitive telecommunications environment to build the Information Highway infrastructure, by considering ways and means of encouraging demand for the new Information Highway-based products and

services. The second challenge is how to address the concern that while the Information Highway and information technology are creating new high-technology jobs, they might also be leading to net job losses in the economy, as well as underemployment in many sectors.

In order to ensure that the employment potential of the Information Highway is realized several avenues need to be explored. Ultimately we must find ways to use information technology for more than just reducing labour costs, and focus on technology that provides new products, industries and jobs. We also need to create policies, legal regimes and market mechanisms to promote economic activity on the Internet, and to assign it a monetary value. If not much of the talent and energy now being directed to the Internet will not be sustained, and the promise of electronic commerce will not be realized. The cost of infrastructure access is also an issue. Pricing to cover the fixed costs of developing new technology and building infrastructure can range across a spectrum from a low volume/high price strategy, to one based on high volume/low price. However, the latter strategy may have extra benefits, in that low cost access will create the broad consumer base to foster demand for new products and services. Finally, the public sector must also continue to play a role in support of Information Highway activities and in the delivery of public services such as education and health.

The debate on the second policy challenge, the relationship between technology and jobs, is quite contentious, reflecting the underlying uncertainty as to the ultimate impacts of information technology. At present, employment levels have not improved substantially in most parts of the world, despite the impressive gains in technology. While many areas of high technology are experiencing significant job gains, in some high profile cases high technology sectors have lost jobs during periods of expansion. Outside the high technology sector, there have been many instances where technology has led to decreases in employment. This uncertainty with respect to technology and jobs is doubly disturbing because a great deal is at stake: in our society jobs are the primary source of purchasing power, thereby allowing individuals to have access to goods and services.

Employment and wages are critical in sustaining the economy, as Henry Ford implicitly acknowledged when he advocated paying higher wages to his workers so that they could afford to buy the cars they were producing. Just as high levels of employment can lead to a virtuous spiral of strong demand, increasing output and increased demand for labour, adding up to steady economic growth, it is also possible that low employment can weaken demand, decrease output and thus decrease demand for labour. Could a technology-driven decrease in demand for labour precipitate such a decline? Even if it is not considered a high probability outcome, arguably we should give some attention to how such a crisis would be addressed, particularly in an era where concern for deficits has weakened public capacity to stimulate demand.

Consumption of information goods not only requires income, but also the time to absorb and enjoy them. Paradoxically, leisure is decreasing for many of the high-paid knowledge workers, while those without work have nothing but leisure time. A situation where those with money have

little time, and those with time have little money is not auspicious in terms of developing markets for the knowledge-based economy.

A review of the situation in Canada, other jurisdictions, and the media makes it clear that there is growing interest in economic issues beyond the initial prescriptions of creating a competitive marketplace and encouraging the rapid development of the Information Highway. All express unambiguous concern regarding the potential impact of technology on the divergence of wages in the economy. Further, at least in the case of Europe, there is a call for more study to provide convincing evidence that the Information Highway will not lead to net job losses in the short and medium run. Outside of governments, we find the media presenting much more forceful criticisms by individuals such as Rifkin, Angell, and Menzies, who argue that the current transformation will have enormous negative impacts on employment, equity and social cohesion. But besides being a popular media issue, some organizations and jurisdictions are showing a willingness to be innovative in the labour market, and are examining and proposing measures to specifically address the employment issue, such as shortened work weeks and creating fiscal incentives to increase employment.

The Steering Committee has addressed the contribution of the Information Highway to economic development and employment in terms of the dynamics of markets, innovation and technology diffusion. It leads to three major conclusions that are relevant to the role of the Information Highway in the transition to a knowledge-based economy. First, the emphasis on creating an environment to promote investment in infrastructure remains vital for economic growth and is supported by the policies followed in other jurisdictions. We must continue to pursue these policies in order to ensure that Canada reaps the full benefits of the Information Highway, and maintains its competitive position. The second is that more needs to be done to foster the development of markets for new Information Highway products and services, which are the base for the new economy. This would entail policy and other measures aimed at stimulating both the supply and demand of Information Highway services, applications and content, that will translate into wealth and employment. The third is that, as with all new technologies, there are some unintended negative consequences which may occur, and that we need to determine if mitigating measures are required, and if so, what they are. IHAC encourages further policy research in this area, ongoing public discussion and debate, and the exploration of policies that provide alternative mechanisms to deal with the possibilities that the number and quality of jobs generated may not meet expectations. Both the success of the Information Highway, as well as our broader economic well-being, are at stake.

TECHNOLOGY, INNOVATION AND GROWTH IN THE MODERN INDUSTRIAL ECONOMY

The Information Highway is extending the technological frontier of modern society, bringing opportunities, challenges and uncertainty. Information technology heralds profound technological and social change, challenging society to revisit fundamental assumptions about how our institutions should be organized, how we should conduct our personal and social interactions, and particularly how our economy will function. To meet the latter challenge successfully requires a judicious sifting of economic theory, historical precedents and current developments. Preliminary work has been done, indeed the paper will selectively survey this work to assess where we are, what trends can be anticipated, and what policy directions should be explored and pursued. This will include: an examination of the modern industrial economy in light of new developments in economic theory; a look at the evolving policy directions of other jurisdictions; and, an analysis of outstanding policy challenges and opportunities. This cannot be comprehensive, as our knowledge and understanding of the ongoing transformation are limited. Uncertainty is magnified because the economic impacts of the Information Highway are determined by a complex interplay of technological, economic and social factors. While it is not possible to explore all the facets of this interplay, the following section briefly surveys some of the key themes.

The Broader Context

Globalization is a key factor driving change, and in dynamic interaction with technology trends, is shaping the development of the information economy. In the marketplace, several factors have lead to the accelerating growth in international trade. Growing economies of scale in key products such as microprocessors have made it uneconomic for all countries to have domestic production facilities. Ongoing liberalization of trade, both internationally in the GATT/WTO and in regional agreements such as NAFTA, has opened domestic markets to foreign competition while providing global markets to local firms. Production is no longer concentrated at a single location, but instead spans the globe depending on regional costs, infrastructure and skills. A modern product can have its components produced in three different countries, be assembled in a fourth, have its marketing done in a fifth, and be sold in a sixth.

Of course, in what *The Economist* has termed "the Death of Distance," technological advances in communications have allowed further coordination of distributed factors of production, to the extent where software workers in India can deliver new code to US firms overnight. Indeed, the transition to what has been called the "global information society" (GIS) will further accelerate the shift to global markets and systems of production.

As the economy shifts to a global field, pressures arise on other fronts. Global security, which some thought might fade in the background with the collapse of the cold war, has only shifted its emphasis. Pressing security concerns are arising from local skirmishes that threaten to expand and jeopardize global stability. As well, environmental pressures such as ozone depletion and climate

change are necessarily global in nature. Addressing many of these concerns will require international coordination, but at the same time as these pressures mount, our international institutions are undergoing enormous stresses from expanding responsibilities, decreased funding, and the ever present challenge of trying to reconcile competing global interests.

Public institutions at all levels are facing enormous challenges. Budget constraints are limiting governments' capacity to act, and yet public expectations are not necessarily diminishing apace. Technological innovation also poses challenges and opportunities for governments. It allows better service delivery at lower costs, but also brings new challenges, such as controlling illegal material, and developing monetary and fiscal policy in the context of digital transactions, and new types of E-money.

Internationally, the problems of underemployment and unemployment seem increasingly intractable. The policy choices for the developed nations seem to lie between two unattractive alternatives. The European and Canadian approaches maintain minimum wage standards and provide a strong social safety net, but suffer from persistent high levels of unemployment. The US, with greater wage flexibility and a minimal safety net, has benefited from low levels of unemployment. However, it has seen large increases in income inequality, deteriorating living standards for the poor, higher crime rates and a health system that cannot meet the needs of all its citizens. Noting the US alternative, Business Week observes: "[o]ne recent French poll showed that 66 percent of the respondents prefer France's rich benefits and high unemployment to America's low jobless rate and tattered safety net." (Feb 24, 1997)

While the globe is being transformed by these economic and social shifts, science and technology continue to play an increasingly important role. Modern society is confronted by a bewildering array of new developments on many fronts. Probably the most notable is the Information Highway itself, though other technological developments are also generating opportunity, profits and controversy. Biotechnology, for example, is creating new drugs to save lives, but is also generating ethical dilemmas in areas such as new reproductive technologies.

The ultimate impact of a technology is determined by the complex interactions between the technology and factors such as historical and cultural circumstances, personal preferences, the reaction of governments, complementary innovations, and of course, the existence of a thriving marketplace with the capacity to develop and market the technology. Even if new technologies are generally embraced, the accelerating rate of technological change itself can create stresses. Never before have the development and implementation of such technology occurred at this pace. In the marketplace this is seen in ever shorter product development cycles, increasing to R&D expenditures to stay ahead, but less time in which to recoup those costs. On a personal level, many individuals are enthralled by the promise of the technology and the new products and services being offered, but at the same time many feel overwhelmed by the accelerating pace of change, and worry about being left behind.

The Information Highway is unrolling in an extremely complex and dynamic global and domestic environment. Thus as we assess the economic opportunities and impacts of the Information Highway, we must recognize the limitations of an analysis that restricts itself to the economics of the Information Highway. A significant shift in many of the areas described above could have a major influence on the implementation of the Information Highway and how its products and services are made available. In particular, general economic conditions such as the state of the business cycle, interest rates, consumer confidence levels, and economic and policy shifts experienced by our trading partners (especially the US), can have considerable impact on the development of the Information Highway in Canada. Nevertheless, it is clear that technological change is essentially inevitable. The policy challenge is to ensure we can fully enjoy the potential benefits, while anticipating and addressing the equally inevitable problems that will arise.

New Services and Benefits Offered by Information Technology and the Information Highway

Every new technology brings the promise of new goods and services, and one of the most striking aspects of the Information Highway is the accelerating stream of new technologies, products and services being offered. Most of these show strong potential to improve both the quality of people's lives and the performance of firms and organizations. The next sections review some of the specific technological and economic trends that provide the context for the development of policies on the Information Highway, economic growth and job creation.

Rise of the Internet

In the three years that the IHAC has existed, the Internet has developed from a relatively obscure tool for the research and education community, to a global mass medium that many see as the core infrastructure of the Information Highway. The relative simplicity of navigating the World Wide Web allows users to easily bring information of all sorts right to the home, be it an essay, a news article, or a digitized painting. Much as word processors put the power of the printing press on every desktop, the Internet further expands this power to enable the production and distribution of multimedia content to a global audience.

The Internet is the network of the many diverse and disparate networks using the TCP/IP protocol to interact with each other. This standard is one of the Internet's greatest strengths, providing a common development platform that reduces the risk of investing in complex products and systems, reduces barriers to entry, and has led to the creation of a new digital marketplace. This common standard has not precluded diversity: many different types of hardware and software still exist, but the common language of the Internet allows effective communication and interaction.

The growing Internet infrastructure is also stimulating further innovation, and development of a rich diversity of products to meet new market niches. The Internet itself is evolving continuously, with a capacity to deliver multimedia content, a mix of text, sound, video, graphics and animation.

This has required Internet providers to rapidly scale up their performance to handle multimedia's bandwidth requirements.

These developments have made the Internet immensely popular, and it continues to grow exponentially, reaching more and more people across the globe. At some point this will slow down, but at the moment new users and new multimedia applications spurred a 500 percent increase in traffic in 1996. The Internet has grown so quickly, it is experiencing "growing pains." There are notable delays for users at peak times of the day. Indeed, the dynamics of usage – an average 20 minute connection, compared to the three minute call assumed in telephone network design – are putting a huge burden on the public telephone network. In some regions of the US, the ability to get a dial tone has been affected.

Congestion difficulties are being addressed in several ways. Pricing and quality of service models are being developed to handle traffic in a manner appropriate to the application being used and priority desired. Technological solutions continue to be developed, but tend to shift the bottleneck to a different part of the network. As billions of dollars continue to be invested in infrastructure to provide broadband capacity (i.e. a bigger "pipe" to quickly transport very large data files such as video), the Internet will increasingly be able to handle diverse networking demands.

The Dynamic World of Networking and Computers

Driven by innovation in a highly competitive and growing market for network services, the development of new technologies continues to accelerate. In the home, new technologies such as ADSL (Asynchronous Digital Subscriber Line) and connections through the cable television infrastructure are responding to market demands for faster connections. In the core, telecommunications companies are laying more fibre optic cable between locations, while researchers are finding ways to send more data down each fibre. The switches and routers that direct traffic around the Internet can perform an increasing variety of functions, faster and with greater efficiency.

Wireless techniques are also advancing, with new digital cellular phones blurring the line between phone, pager and E-mail. In Canada, recently licensed LMCS (Local Multipoint Communications Systems) networks will soon become available, providing multiple video channels and high speed Internet access to a small dish at the subscriber's home. Satellites in Canada already provide Internet access to remote regions, and may provide a competitive alternative to fibre for backbone network services, and delivery of high bandwidth files (e.g. DTH/DBS). The deployment of networks of LEO (Low Earth Orbit) satellites will add a further means of general connectivity to the Internet.

On the desktop, modern processors provide users with the power of yesterday's supercomputer. Applications continue to become more powerful and are now often distributed and maintained online. While applications such as word processors become Internet connected, Internet browsers

are now moving into the computer's operating system, further blurring the line between material on your own computer, the local area network, and the wider Internet.

Computers continue to evolve at a dramatic pace. The newest PC's have integrated design principles from consumer electronics, and many of the new home models combine the functions of TV, stereo system and PC. Each successive generation of portable computer is becoming more powerful: laptops have comparable power to standard desktops; personal digital assistants (PDAs) are increasingly popular, offering improved handwriting and voice recognition, network integration, and more power. There is also a strong growth in "information appliances," featuring new computer power in traditional products. Already, 90 percent of the computer chips sold are not used in PCS, but in cameras, braking systems, and other appliances.

This is the world defined by the convergence of once separate technologies in computing, telecommunications, broadcasting, information handling and consumer electronics. Clearly the dynamism of information technology is remarkable, and even those working in the field have trouble keeping abreast of all the developments.

New Applications

Networking and computer technologies are wiring the planet, but ultimately what matters is the applications, content, and services that will provide value to users. Just as E-mail, file transfer and browsing have driven growth to date, new products and services will encourage demand, and provide incentives for further network expansion.

Cutting edge technologies in the corporate world are harbingers of the future work environment. Intranets, private versions of the Internet model using the same protocols, are being used to provide internal information in a secure environment. Because Intranets do not suffer from the security concerns and the computing and bandwidth constraints on the Internet, the Intranet market is growing rapidly, driving the development of new, more sophisticated applications. Two-way audio and video transmission to enable video conferencing, indexing and searching capabilities, collaboration tools and "groupware" are all examples of the demanding new applications being developed.

Government also has a role in generating new applications in areas with a public sector focus. Research facilities such as the Communications Research Centre are developing advanced technologies in areas such as interactive video over the Internet.

Applications continue to develop that expand the ability of individuals and organizations to automate menial tasks and engage in new activities. Although the key role of the underlying network and computer technology cannot be denied, such resources have little value without new applications to generate and transmit content for consumers.

Lessons from Economic History and Theory

The new services and products flowing from the Information Highway offer many obvious benefits and improvements to our quality of life. It is equally clear, that the development of the Information Highway and new products and services are a source of economic growth and employment. However, it is much more difficult to determine the broader economic impacts of the technology, and how to maximize the potential benefits. A brief review of current and historical analyses of economic growth provides a useful starting point.

Historical Context

The past 200 years saw a radical shift of the economic base, from a society based on agriculture to one based on manufacturing, that transformed our way of life. Historically, workers did not have jobs as we know them today. Work has been organized through many structures, including the feudal system, guilds and independent producers, as part of an agricultural society. The Industrial Revolution shifted most of the population from agriculture work to manufacturing; indeed only 3.2 percent of total employment in 1995 was in agriculture.[1]

An economy based on manufacturing required a whole range of new institutional relationships. Work became structured around a job with a wage, as the new economic base generated incomes that supported the growth of a huge variety of new services. New social norms arose that profoundly affected the role and status of women. Democratic institutions gradually strengthened, and governments took on new roles. They began to develop the infrastructure to support industrial development, such as roads, canals, sewage systems, electricity, and eventually telecommunications. New social polices, such as unemployment insurance, were instituted to meet the needs of a manufacturing society.

Overall, the Industrial Revolution brought new goods and services, generated enormous efficiency gains, and created far more jobs that it displaced. In many ways it epitomized what Joseph Schumpeter called "creative destruction" – capitalism's capacity, through waves of technological change, to develop entirely new industries which displace existing ones.

The Current Transition

The current technological transformation centres on the technologies of information and communication collectively called the Information Highway. Many see this transformation creating a new economy based on knowledge and information. While this transition is not complete, several aspects of this transformation can be noted.

The adoption of any technology depends on market forces, as ultimately, the success of a new product rests on its ability to provide value to the consumer. Cellular phones free the consumer

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[1] Although the food industry itself is much larger and employs many more people.

from the constraints of wires, and provide mobility. VCRs allow consumers to control what they watch and when they watch it. Banking machines allow people access to funds outside of a bank's business hours. The Internet allows users to find and receive information from around the globe without leaving their home or office. All of these developments give people more control and power over their lives.

As it stands now, some argue that Information Highway services are basically substitutes for existing services, and that the Information Highway is really nothing more than an efficient delivery mechanism, generating little in the way of new employment. Actually, the Information Highway combines different media into a single electronic marketplace, and has already generated new content and new ways of doing business. But is it a new economic base? Does it generate the wealth to support new services, as manufacturing did? In the wake of pervasive technological change, new institutional relationships will be necessary to support the changing environment, but at such an early stage of development the answers to these questions remain unclear.

Innovation and Economic Growth

The essence of modern economic growth lies in innovation. There is higher quality of life today not because we simply have more of what our ancestors possessed, such as foodstuffs, clothing and basic shelter, but because we consume new and better things and have superior ways of producing them. We have new medicines, new ways of working, new forms of organization and new institutional mechanisms. Canadian economist Richard Lipsey notes the consequence:

> "Major technological advances – such as writing, printing, steam power and electricity – come along rarely, but when they do they trigger deep structural adjustments across the whole economy... Such change creates immediate victims – large pockets of lowered living standards and broken lives – but ultimately makes life better for future generations, just as today's generation enjoys the benefits of changes their ancestors paid for."

At a broad societal level, the West became rich, not due a single or even a handful of technologies, but from creating a society in which innovation was constantly occurring. Until recently, economists working at the macroeconomic level did not note technological change as anything more than an isolated variable that increased gradually over time. Technological change was considered outside (or exogenous to) the economic levers available to policy makers, particularly at the macroeconomic level. Certain policies supporting intellectual property, educational facilities and R&D were promoted with an understanding that they would encourage innovation. But the macroeconomic link to increased growth rates and long-term prosperity was never made explicit. New growth models are being developed that include an interaction between technological development and other key micro/macroeconomic variables.

Part of the difficulty in developing policy on innovation arises due to problems in measuring the impact of innovation. Innovative activity is often highly *qualitative* in nature, making it extremely

difficult to capture economic growth with traditional statistics such as GDP, which emphasize quantity rather than quality. When the rate of qualitative change was slower, measuring year to year changes in GDP as a proxy for growth was acceptable, because the statistic reflected how the new products were being diffused through society. But in a world of pervasive innovative activity, new measures that reflect both increased production and real changes in quality of life, are necessary.

As an example, we are more productive due to the innovation from computers and networks described above, but these gains fail to show up in the statistics, generating what many economists refer to as the "productivity paradox." Consider that even though the car of today is vastly superior to those of 20 years ago, such improvements would not be captured in statistics measuring the output of the automotive industry using the number of cars produced. In the information technology industry, qualitative improvements have been much more dramatic. *The Economist* notes: "If cars had developed at the same pace as microprocessors over the past two decades, a typical car would now cost less than $5 and do 250 000 miles to the gallon." If this is the case, in some areas, we may be vastly underestimating economic growth and productivity increases.[2]

In a modern economy, what is not measured is often ignored. We need to ensure that our systems of economic measurement provide as true a picture as possible, so that policy and allocation decisions reflect our real priorities.

Ideas and Nonrival Goods

Traditional economic analysis is based on the exchange of scarce physical goods. In a knowledge-based economy, ideas and information effectively overshadow physical goods and services as the primary units of production, distribution and consumption. While physical goods and services will continue to play an important role in the economy, their relative significance will decline in future. This change in the nature of the market commodity has some unexplored economic consequences.

An idea or information good is called "nonrival" because it can be consumed by many people at the same time without any loss of functionality to the original user. Digital products, such as a piece of software, can be used by one person, but can also be perfectly and freely copied and used by several other people without affecting the first user. This is quite different from rival goods and services, such as bread, chairs and haircuts. While nonrival goods can be infinitely shared, short of divine intervention, a loaf of bread can only be shared with a few people, and everyone gets less as the number of diners increases.[3]

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[2] Similarly, mismeasurement can overestimate growth, such as the clean-up of the Exxon Valdez disaster, which registered as a billion dollar increase in the GDP of the US.

[3] The division between rival and nonrival goods is not absolute, for many goods can have elements of both. Some nonrival goods become rival when congestion sets in, such as a public concert in a hall with limited capacity. Until the hall is close to full, most patrons will enjoy the concert fully, regardless of the presence of

This does not mean that scarcity necessarily disappears in favour of abundance, for the unlimited sharing in one dimension is often complicated by scarcity in another. While copies of a digital text may be basically limitless, there is still scarcity in terms of the time and talent of the writer, and the time and attention of the reader.

The unique features of nonrival goods demand a different economic analysis, one that captures the shifting relative importance of fixed costs and marginal costs. Manufacturing a rival good, such as a chair, requires initial fixed costs in design, financing, and building a factory. The same is true for a nonrival good, as producing a piece of software requires a significant amount of upfront capital and labour. But each chair produced requires physical equipment, labour and materials, and it is these latter expenses, the marginal cost per chair, that dominate the total cost of production. For a nonrival good, all of the effort goes into producing the first copy. Thereafter, it can be copied at virtually no cost. Similarly, while distribution of the finished chairs involves a transportation cost, for software again this is minimal, especially if delivered over the Information Highway.

Nonrival goods display increasing returns to scale, because the average cost per unit falls as output rises, spreading fixed costs out over more copies. This undermines several axioms of the standard economic model. The traditional link between increased output and employment breaks because the cost of producing one copy is virtually the same as the cost of producing a million. Pricing of nonrival goods is also complex. Market forces may not result in a single market clearing price, but can produce several competing pricing schemes, which may not guarantee an economically efficient outcome. Nonrival goods can also form the basis of sustained growth of the economy because the human capacity to rearrange ideas to create new information products is almost unlimited, and the production of information goods is not generally constrained by factors such as scarce physical inputs or unacceptable environmental damage.

Intellectual property (IP) laws have been developed to deal with some of the challenges of nonrival goods. Illegal copying of software is only the latest example from a long history of intellectual property piracy. Any digital information transmitted on the Information Highway faces similar threats, and thus intellectual property and copyright concerns have challenged legislators, content producers and technology suppliers alike. The latter are attempting to use "cryptolopes" and "digital watermarks" to protect their investments. Others stress the need to find new business models, such as giving information away free but gaining revenues from advertising, or by tolerating pirated copies of a musical work because it provides free publicity for concerts that provide a group's core revenue. The new technologies do not change the long-standing goal of

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other listeners. Technology can also play a key role, by transforming a somewhat rival good, into one that is almost perfectly nonrival. Hand-written books before the printing press were only accessible to a privileged elite: now a digital copy of a book can be transmitted to millions of readers with remarkable speed and ease. Indeed, as technology advances, digital information becomes almost a pure nonrival good. Further, it is important to note that the same features that make some things nonrival goods, also can make others "bads." Digital technologies that enable the spread of useful information also enable the spread of socially damaging information, such as bomb-making instructions and child pornography.

having the intellectual property rights system maintain a balance between the needs of users and creators, but achieving that balance has become more elusive.

What are the implications of a shift from an economy based on goods exhibiting constant or decreasing returns to scale, to one based on goods with increasing returns to scale? As information and knowledge assume an increasing role in the economy, much work needs to be done to further elaborate our economic understanding of nonrival goods, particularly at the macroeconomic level. The next section raises a few of the issues.

Markets and Increasing Returns

Debate exists in the economic literature as to whether market forces will be as efficient in supplying nonrival goods as it is for traditional, rival products. In the high technology sector generally, and with nonrival goods particularly, the market model is one of "monopolistic competition." In these cases, extremely high upfront costs of research, and uncertain market outcomes, pose huge barriers to entry and limit the number of players competing. Thus participants must charge a premium over the cost of production in order to reap a fair reward. The important point from the perspective of growth, according to Paul Romer, is whether the monopoly "has reached the point of stifling creativity and slowing the discovery of new ideas."

Brian Arthur has noted that the current transformation in Western economies, from the production of physical goods to the processing of information and application of ideas, highlights the role of increasing returns to scale in modern markets. One result is that products that get ahead, by being first to market or by historical accident, tend to get further ahead and "lock in" the market. However, such monopoly power is not without benefits to consumers.

One advantage of lock-in is that the more entrenched a technology becomes, the lower the risk that new adopters will purchase a soon-to-be obsolescent technology. As more people adopt a technology, the cost of the technology falls, thereby making it even more attractive to users and developers alike – leading to further development and improvement. Furthermore, it does not pay users to switch to a different technology, once they have invested the time in learning how to use it. For a network, like a telephone network or the Internet, network externalities exist that make the network more valuable, the more people are on it. All of this means that the best product, standard or technology does not always win, because the "bandwagon effects" can lock-in technologically inferior products. Generally speaking, a superior technology will not easily displace an inferior one unless the benefits of it are an order of magnitude improvement.

Hence increasing returns markets tend to have a market leader that captures most of the share of that market. Yet, the rapid progress of technology means that maintaining this dominance is not assured. In such a volatile system, new developments can move competition to the next high stakes market or "game," where the shape of the game and its rules are highly uncertain at the outset. Brian Arthur notes that the rewards will go to those that can best anticipate how the next game will unfold.

Conclusions on History and Economic Literature

Three key messages can be distilled from the growing economic literature on the Information Highway and the shift to a knowledge-based economy. The first is that we are undergoing a transformation as profound as any previous economic shift, including the industrial revolution. In the wake of such pervasive, transformative technology, everything must change, from economic structures to social and political institutions. While some argue that the lesson of history is that despite temporary winners and losers, eventually we will all be better off, we must still manage this shift to ensure the benefits are forthcoming.

The second main theme is that policy makers must explicitly acknowledge the central role of innovation in generating wealth and economic growth. Our policies must reflect the need to encourage basic innovation and its application in developing products for the marketplace. Public institutions must be just as innovative, for example in the delivery of health and education, if we are to fully capture the economic benefits of technology. Policy makers must also be aware of the key differences between the diminishing returns world of manufacturing and the increasing returns world of modern technology, and should consider the inherent characteristics of nonrival goods.

The third main theme is that the shift to a knowledge-based economy will bring some unique challenges. On one hand, in a global economy, if Canada does not create the products and services for the Information Highway, they will be created elsewhere, and we will not reap the spillover effects of a new economic base. On the other hand, prudence dictates that we try to anticipate the impacts such a transformation will entail. This will involve revisiting our fundamental assumptions and thinking about the dynamics of a knowledge-based economy.

EVOLVING POLICIES FOR THE INFORMATION ECONOMY

The pace of current developments in information technology and the Information Highway provide a quintessential example of the effectiveness of the marketplace in providing new technologies, products and services. This conclusion, that a dynamic, healthy, and competitive marketplace is a necessary condition for domestic economic success, is embraced almost universally in developed countries, and has formed the basis for policy development around the world. This section highlights some of the details on how countries are engaging the challenge of providing for a competitive marketplace and industry in their jurisdictions, beginning with Canada.

Canada and the Information Highway Advisory Council Phase I

In its first phase, the IHAC commissioned and developed several works prior to developing its conclusions in its Final Report. *The Economic Impacts of the Information Highway: An Overview*, by Mark Potter and Marc Lee, was based on the background material for, and discussions among, the Task Force on Growth, Employment and Competitiveness of IHAC Phase I, and was approved by IHAC for release as a discussion paper. The paper concludes that the private sector is, and will continue to be, the driving force behind developing the Information Highway, arguing that a market-based approach will have the greatest impact on growth, competitiveness and employment. Nonetheless, it identifies an essential role for government in shaping a competitive legislative, regulatory and policy environment, in using the Information Highway to improve organizational efficiency, in reforming the learning system, and in building a consensus on policies in areas such as intellectual property, privacy/security, standards and cultural development.

Similarly, IHAC's Final Report notes:

> "The most effective way we can respond is to move away from regulation and rely more on market forces... Canadian firms using the technology, products and services of the Information Highway can improve their competitiveness on a global scale and create jobs at home. So too can governments in Canada look to the Highway to improve services and reduce costs. It is these themes – increased competition, new jobs and better government – that comprise the framework for the recommendations of the Working Group on Competitiveness and Job Creation."

The final recommendations relating to jobs and growth centre around measures required for creating a competitive market environment, but also address issues such as R&D incentives, creating jobs through content development, and the need to develop public infrastructure in areas like health and education. The specific recommendations dealt with establishing the market framework to achieve these aims.

Many of these recommendations have been addressed by the Canadian government. *Building the Information Society: Moving Canada Into the 21st Century*, the government's progress report and action plan on the Information Highway, provides a synopsis of the actions taken in this area. Amongst the actions completed or underway are: developing Convergence policy; frameworks for satellite and new wireless communications services; Phase II of CANARIE; ongoing work in setting standards, particularly in cooperation with industry; electronic commerce; R&D policy; Technology Partnerships Canada; Strategis, an extensive online source of government information; increased financing support for knowledge-based industries; and work on labour standards.

The Canadian government is committed to encouraging the Information Highway and particularly to support the private sector in generating the economic benefits promised by the technology. As this commitment is critical to maintaining Canada's international competitiveness, we must remain vigilant in monitoring our progress in pushing this agenda.[4]

The United States

As a nation, the US is undeniably the major player in almost all emerging markets of the Information Highway. The Internet was born in the US and now it is the hub for Internet connections to most other countries. A huge proportion of Internet content is based in the US. And in some cases, such as in Asia, traffic between those countries themselves is routed through the US (though to the dismay of US carriers). Moreover, the dynamism of the US market-driven approach is evident in Silicon Valley, arguably the home of the information technology industry, and in regional clusters such as Boston, Redmond, Washington, and Dallas. The US has huge, multinational players in virtually all of the information technology, communications, media and cultural sectors, backed by a powerful government with wide-ranging influence.

Development of a National Information Infrastructure (NII) has been a central policy concern in the Clinton administration. It is a particular interest of Vice President Al Gore, who has championed the NII and its applications as the economic foundation for the 21st century. The US approach is also focused on a NII that will be built and maintained by the private sector. Since completion of the transfer of the National Science Foundation Internet backbone to MCI Communications Corp. in 1995, commercialization of the Internet has led to a building frenzy, and there are now many backbone providers operating at national and regional levels.

This emphasis on competitive market forces lies behind the 1996 *Telecommunications Act*, a major deregulation of the telecommunications sector (albeit with several unresolved issues such as "unbundling" of services and conditions of interconnection). Competition on the Information Highway has been opened for companies in information technology, local and long distance telephony, cable, satellite and media and entertainment in what *Business Week* calls a "$1 trillion

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4 IHAC is intending to report on these issues at the end of Phase II.

free-for-all." Deal-making, mergers and restructuring are ongoing as the major players position themselves for the next round of battle for new markets.

A key role for government in the NII is as "catalyst to promote technological innovation and new applications." In this spirit, the Next Generation Internet Project is being funded, at $500 million over five years. The aim is to provide high-speed connectivity to encourage the development and testing of the next generation of Internet applications, protocols and technologies. A related (and overlapping) initiative by 100 universities, called Internet II, is also unfolding with $100 million in funding coming from the universities themselves.

European Union

In Europe, the overall context for the development of the Information Highway was first framed with the 1994 Bangemann Report, presented to European Heads of State by leading European industrialists. The Report notes that "private investment will be the driving force" of the European Information Highway and that "[m]onopolistic, anti-competitive environments are the real roadblocks to such involvement." Shortly after, the European Council responded with an action plan for the Information Highway in Europe, with priority given to implementing the principle of competition in the telecommunications sector, as the central instrument of regulation. January 1, 1998 has been set by the European Union for full liberalisation of the remaining telephony monopolies, as well as network infrastructure, in 15 European Union countries, and Switzerland and Norway .

At national levels, countries such as the United Kingdom, Sweden and Finland have already opened their markets. In anticipation of January 1, 1998, rules are already being loosened and competition is thriving in markets where it is able, such as in cellular telephony (liberalized since 1990) and corporate networks. Moreover, start-up companies backed by US capital markets are emerging to take advantage of lucrative niche markets. Among the most ambitious plans is the Global Telesystems Group, which is building a pan-European fibre optic network using railway rights of way.

Europe is establishing major linkages to the US, as global telecommunications alliances are being struck to offer international services. Examples include the acquisition of MCI by British Telecom, and a 20 percent stake in Sprint by Deutsch Telecom and France Telecom to form the Global One alliance. AT&T already has alliances with 16 international phone companies through the WorldPartners consortium. Given the size of the European market and the high telecommunications costs posed by incumbent monopolies, such positioning to form global alliances can only be expected to increase as the European market liberalizes.

Asia

The past two decades have witnessed the rise of powerful new economies in the Pacific Rim, with strong export performance. These countries are increasingly viewed as new markets by Western

nations, but also have received substantial investment in production facilities from Western companies.

Asian economies are progressing rapidly in dealing with the challenges of the Information Highway. In more market-oriented economies, state-owned infrastructure is being replaced by competition. New infrastructure development is allowing nations to leapfrog to next generation technologies without concerns about sustaining investment in existing facilities. Singapore is positioning itself as the major regional hub for networking and Internet publishing. In Malaysia, ambitious plans are underway for a "Multimedia Super Corridor," a 750 km^2 area near Kuala Lumpur, to be wired with smart buildings and a leading edge infrastructure, including the building of a new administrative centre for government and an "Information Technology City." Japan, of course, is a market leader several information technology niches and NTT is the largest telco in the world. One wild card in the region is China, where the potential of its huge market size must be weighed against political and economic uncertainties.

The Asian economies rely on market forces, yet a strong government presence often provides a common economic vision to mobilize resources and focus development, leading to the expression "massaged market economies." Despite the adage that governments are not good at choosing winners, some argue that the Asian economies show that such efforts can be successful. Ultimately, it is difficult to assess whether such an approach will be effective in developing applications and content for the Information Highway. Nevertheless, most agree that these new economies represent a substantial competitive force in the global information economy.

OECD

The OECD has looked at the economic policy issues arising from the Information Highway in a number of contexts and produced several documents. The two most prominent studies are the major study on Technology, Productivity and Jobs, (TPJ) which released its first report in 1996, and is now beginning a Phase II initiative, and the ongoing work on the Global Information Infrastructure - Global Information Society (GII-GIS).

The TPJ study endorses the economic importance of technology, recognizing the central role of firms in delivering economic benefits, and thus the need for competition and an effective information infrastructure:

> "Technological change results from investments, such as R&D, and creates opportunities for further investment in productive capacity. This is why, in the long term, it creates jobs and more income. A main task for governments is to create conditions that induce firms to engage in the investments required for enhancing technical change." (OECD, 1994b, page 7)

While the work on the GII-GIS has not yet been completed, the OECD Ministers, in a joint statement, note:

> "The globalization of the economy is the product of the interaction between trade and technological progress... To take advantage of these prospects for improved living conditions and progress, individuals, enterprises and countries must show themselves capable of rapid adjustment and continuous innovation."

Summary

All of these examples show that the economic approach and policies advocated by the IHAC and being implemented by the Canadian government to be consistent with those of other jurisdictions. The key message is the need for quick action to take advantage of, and promote technological change. The consensus is that the marketplace is the best way to promote the development of the Information Highway and the content and applications which will create economic growth. All countries are actively pursuing programs to implement these policy prescriptions, and it will be necessary for Canada to keep up in these areas if it is to fulfil its goal of being in the forefront of the information economy.

Nevertheless, other economic policy areas of concern are addressed by these countries and organizations, and in some cases there is not a clear consensus on what should be done. The broader role for government varies somewhat in terms of policy prescriptions. Government sets the framework within which markets must operate, and in times of significant economic transformations, there may be an ongoing government role to ensure efficiency of commercial, financial and labour markets. These broader issues are addressed below, but first, we examine some of the empirical data and public opinion surveys on the Information Highway, economic growth and jobs.

JOBS AND GROWTH: QUANTITATIVE ANALYSIS

The policies and analyses reviewed above implicitly reflect the empirical evidence collected to date (as interpreted by current economic analysis and research), as well as the trends in public opinion. This section briefly reviews some of the empirical studies and opinion polls, both as a touchstone both to affirm that current policies are grounded on real measurements of performance and address public concerns, but also to link to the next section on policy challenges and opportunities. In an area as dynamic as information technology and the Information Highway, public policy must be constantly verified against performance and expectations, so that gaps and opportunities can be addressed in a timely fashion.

General Economic Conditions

Many of the standard indicators of economic well being paint a positive picture of the Canadian economy's performance and future potential. Inflation was at 1.8 percent as of October 1996, with a strong dollar, and the prime lending rate at 4.75 percent, the lowest since 1956. By the third quarter of 1996, GDP growth was up to 3.3 percent on an annual basis, after sluggish performance through 1995 and the first half of 1996. Deficit reduction targets of the federal government have been exceeded, and apart from current interest payments on the debt, Canada is running a surplus. The business sector continues to be strong, with total profits at record highs, and a record $40.5 billion merchandise trade surplus in the third quarter.[5]

On the other hand, other economic indicators are cause for concern. Consumer behaviour seems to be mirroring the corporate world's lean-and-mean efficiency, with weak spending despite low interest rates. Households may be reluctant to spend in times of slow income growth and job uncertainty, and are further constrained by high debt levels. While consumer debt is at a record high of 91.5 percent of annual disposable income (3rd quarter 1996), savings have fallen to an all-time low of 5.1 percent, as consumers borrow and deplete their savings to maintain consumption patterns. Yet, without a resurgence in consumer demand, strong domestic growth will be difficult to sustain.

High unemployment continues to be a key consideration. The unemployment rate has increased steadily, from 5 percent in the 1960's to 6.7 percent in the 1970's, and 9.4 percent in the 1980's, to 10.2 percent in the 1990's, and this is mostly attributed to a large increase in the average duration of unemployment (22 weeks in the 1990's), rather than an increase in the incidences of unemployment. While aggregate employment is rising, the unemployment rate has recently hovered just below 10 percent. Further, many Canadians have become discouraged, are no longer seeking work, and so are not counted as unemployed: labour force participation rate fell from 70 percent in the late 1980's to 65 percent in 1996.

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[5] These and the following figures have been taken from Industry Canada's Micro-Economic Monitor.

For those finding employment, the jobs generally have not been full-time positions. Indeed, over the past two decades, half of all job creation has been in non-standard work (part-time, temporary or self-employed). In 1995, 30 percent of part-time work was involuntary, up from 10 percent in 1976, while the proportion of jobs lasting less than 6 months rose from 46 percent in 1981-85 to 54 percent in 1991-94. The report also notes that in previous expansions, a 1 percent increase in output led to a 0.5 percent increase in employment, while during the 1991-93 recovery, a 1 percent increase in output growth led to only a 0.17 percent increase in employment.[6]

Public perceptions reflect the uncertainty of changing times. According to Ekos, in April 1996, 44 percent of those working feel that there's a good chance that they could lose their job in the next couple of years. This is supported by an Angus Reid poll in Spring '96, that found that 30 percent of Canadians said they felt that they or someone in their family would probably be laid off or become unemployed in the next 12 months. Such uncertainty puts a drag on the domestic economy, as 3.3 million people cut back, and hold off purchases due to concerns about future employment security.

The Information Highway Sector

Current policy approaches for promoting the Information Highway to create jobs and growth are supported by both the empirical evidence and public opinion. First, recent public opinion polls show that most Canadians believe that the Information Highway and information technology will generate more employment and economic growth for Canada, and Canadians support government measures to encourage these sectors. A recent Ekos Survey showed that 88 percent of Canadians agree that "technology and information are the sectors of the economy where we're going to see the most growth"; 87 percent agree that "focusing on technology and innovation will mean that new companies and industries will develop;" and 85 percent agree that "focusing on technology and innovation will help ensure that existing companies will prosper." Earlier data are not available to do trend analysis to see how these views are evolving, but it will be important to track public attitudes on these and other Information Highway issues in future.

In terms of empirical studies, recent evidence reinforces these views, showing that innovative firms are more successful, and that information technology intensity corresponds with higher levels of revenue, profits, and employment. For example, recent work on innovation by John Baldwin of Statistics Canada showed that firms which self-identify as "innovative" (using a very broad definition of innovative) consistently outperform other firms.

The Conference Board of Canada recently released the study *Technology in the Knowledge-Based Economy: Information Technology and the Impact on Employment* which shows that high information technology intensity industries increased employment, whereas low information technology intensity firms showed a decrease. Further, employment grew faster in industries

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[6] Employment figures are from the Privy Council Office's Policy Research Committee Report "Growth, Human Development, Social Cohesion."

which were growing in information technology intensity. Though the study argues that its findings do not support the adage that "information technology is a job killer," the authors are careful to point out that it cannot establish a causal link between the adoption of information technology and increases in overall employment.[7]

In another area, a *Market Assessment Study of New Media Learning Materials* (NMLM), sponsored by Industry Canada, presents the economic potential of this sector, but notes that "the multimedia and NMLM industries are already experiencing shortages of people" who have the requisite skills. This is quite a contrast to many other sectors where there are few jobs and many seeking work.

In terms of employment studies, there is solid evidence that information technology is reducing employment in some industries, notably the manufacturing sector. However, it is somewhat disconcerting that two recent publications show declining employment in the high technology areas. The report by Human Resources Development Canada *Telecommunications Industry in Canada* indicated that employment in that industry had a net decline of 15 000 from 169 000 to 154 000 between 1990 and 1995, and forecasts for 2 000 are 144 000. This decline has been ascribed to the one-time rationalization that took place in the telecommunications sector as a result of the industry's transition from a regulated monopoly to competitive market.

A recent Statistics Canada report *Industry Profile: Canada's Information Technology Sector* showed the industry's output grew an average of 8.1 percent compounded yearly between 1990 and 1995, pushing its share of gross domestic product from 5.5 percent to 7.6 percent. Total employment however, showed little growth, with the number of jobs falling from 316 459 in 1990 to 297 697 in 1993 before rebounding to 324 042 in 1995, reflecting an average compounded growth rate of only 0.5 percent over the five years. Figure 1 provides a graph of these employment figures. One salient and more optimistic result is that the software and services sector saw steady employment increases over this period, rising 32.3 percent from 90 726 to 120 011.

Opinion polls also reflect public uncertainty as to the impact of technology. Ekos reports 84 percent of Canadians agree that "as technology becomes more important in the economy, some people, and older workers in particular, are going to be left behind," while 51 percent of Canadians agreed with the statement "I really worry that new technologies take away more jobs than they create."

All of these findings, while neither decisive, nor sufficient to alter the current policy direction, point to the need for further economic investigations to understand and deal with the impact of

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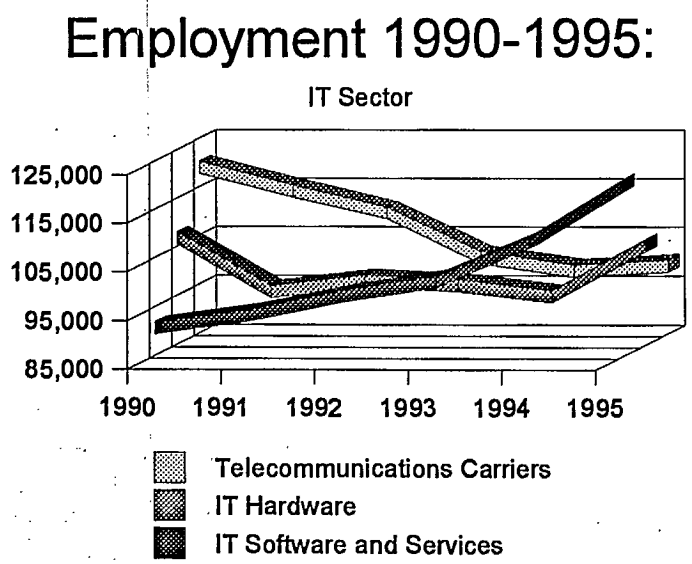
[7] One anomalous result, albeit not a key element of the study, was that the occupational group which was most concerned about the possibility of loosing their job due to computers was science/engineering (17 percent), slightly higher than clerical at 16.5 percent. While the overall percent is not that high, it is noteworthy that an occupation which is extremely highly skilled, very knowledge-intensive, and completely at home with computers and information technology, should be the most pessimistic regarding how computers would affect their employment opportunities.

this technology. Indeed, as the next section illustrates, Canada and other jurisdictions have identified certain specific economic policy challenges arising with the Information Highway, and some are even exploring, or implementing, policy options to deal with them.

Figure 1.



POLICY CHALLENGES AND OPPORTUNITIES

Two key policy challenges regarding the economic consequences of the Information Highway remain outstanding. The first is to expand beyond the narrow focus on creating a competitive telecommunications environment for building the Information Highway infrastructure, and consider ways and means of encouraging demand for the new Information Highway-based products and services. The second challenge is how to address the concern that while the Information Highway and information technology are creating new high-technology jobs, they might also be leading to net job losses in the economy, as well as underemployment in many sectors. Of course the two are related: for individuals to be willing to purchase new services and goods, they must have reliable incomes – which is usually equivalent to being securely employed.

Creating New Products and Services

If the Information Highway is to deliver on the promise of stimulating a new round of economic growth and job creation in the economy at large, it will have to deliver new products and services that provide value to consumers. This will involve both the private sector in the area of general consumer goods and services, and the public sector in areas such as health, education and other public services. A critical element of such a strategy is to stimulate value-added products and services, while minimizing the impact of cost-reducing technologies that usually involve substituting technology for labour.

As we develop policies to encourage new goods and services, we can be guided by our historical understanding of the technology diffusion process. Typically three stages have been identified. In the first stage technology is used to help us do what we have always done, in a similar manner, but with greater efficiency. An example would be having a computer replace a team of mathematicians to perform the extensive tedious calculations involved in planning a space flight. In the second stage, the technology is further developed to provide entirely new ways of doing that which we have always done, such using a spreadsheet program to compare a number of alternative financial forecasts. Finally, the mature phase of the technology allows us to do things and create products not contemplated before, such as the interactive 64 bit Nintendo computer games. It is in this latter phase that we often find the greatest opportunities for job creation.

Innovation has also been categorized as either product or process-based. Product innovation can improve the quality of existing goods and services, as well as generate new ones. It creates new markets, increases overall demand, and contributes to job growth to meet that demand. Process innovation usually reduces labour costs to produce a given level of output, and tends to reduce employment. However, lower prices will increase output levels, and therefore employment (although this is not necessarily the case with nonrival goods, as noted in the first section). Whether process innovation leads to a net employment increase or decrease depends on which of these factors dominate. The exclusive pursuit of cost-reducing technology, without equal efforts

at product innovation, is generally not an effective long-run strategy at the firm level, particularly in the dynamic information technology industry.

Cost reduction tactics such as downsizing have been a concern for the public for some time now, with waves of labour force reductions in both private and public sectors. Whether this strategy does indeed make economic sense at the firm level is the subject of dispute, with some commentators arguing that the loss of human capital, in terms of lost talent, company specific knowledge, and networks of contacts, have offset short-term efficiency gains. Further, at a macroeconomic level, the impact of more unemployed lowers aggregate demand in the domestic economy, which affects all firms, and this "crisis of consumer confidence" is exacerbated by workers' perceptions that their future income prospects are similarly insecure.

Under the current economic conditions, employment opportunities are not keeping pace with the combined effects of downsizing and a growing workforce. Unemployment is statistically understated as discouraged workers have dropped out of the labour force, driving down labour force participation rates in all age categories since 1990. Added to this is a mismatch between the skills of workers being laid off, and the qualifications required by firms in the high-technology sectors where jobs are not being filled. This "skills gap" is the focus of much attention, with lifelong learning and training being addressed by most governments and policy groups, including the IHAC. The difficulty comes in addressing workers that may not have the skills to bridge the gap, such as a 45-year-old laid off assembly line worker. Failure to address this structural unemployment will continue to put a pall on economic growth, and impede the demand for new goods and services on the Information Highway.

Capturing the Economic Value

The Internet has been compared to a "new gold rush," as evidenced by dramatic growth of usage and the steadily increasing volume of information, services, and goods being offered. Yet, so far the rush has yet to produce much "gold" and firms continue to seek business models that work. Traditionally much of what has been provided on the Internet has been produced and made available at no charge. Advertising models that have had so much success in print and television media are attempting to lever free information into a workable model for commerce on the Internet. Though still paltry in terms of total revenues compared to its media cousins, banner advertising on Web pages has proliferated, supporting, for example, Internet search engine services. Also, new firms such as PointCast are coming on-line to "push" personalized news items, and advertising, to the desktop.

Other barriers stand in the way of firms capitalizing on the opportunities offered by the Internet as a consolidated medium for production and distribution of all manner of multimedia content. Governments, banking institutions, small business groups and others are working to create the financial and legal structures to encourage commerce on the Internet. One key area, addressed by IHAC in Phase I, is the clarification of copyright issues since nonrival goods come in a "pure" digital form and cannot generally be controlled by their physical containers. Security concerns are

also an issue. Consumers have not yet been convinced that transmitting credit card information on the Internet is safe, and until they are confident, online business will be curtailed. Once security concerns have been properly addressed, and as more people use the Internet, a boom in online business is anticipated.

The entire question of how the Information Highway will evolve to generate new markets, goods and services, is characterized by uncertainty. Not everything will be purchased on-line, and the precise mix of products and services that will be available is unknown. And to date, materials on the network generally represent substitutes for existing products and services.

Estimates of 1995 Web sales range from US$160 million to US$575 million, with half of sales going to airline tickets. Computer products, books and CDS are also popular. To give an example of potential market size, the mail order catalogue industry in the US in 1995 accounted for about US$50 billion of a US$2 trillion market. Whether Information Highway commerce can exceed this level of penetration is uncertain, though there are other areas to be considered. For example, advertising is a US$25 billion industry, and business printing and publishing amounts to US$80 billion.

New products and service will continue to arise and, as noted previously, those that are successful tend to become very dominant and profitable. The key question is what share of the global economic pie will be captured by Canada and how this share can be maximized. This question has important implications, not only for the players themselves, but for the spillovers that income provides, as it supports other services, public and private, in the domestic market.

Pricing Infrastructure Access

As the Internet continues to make the transition to handle full multimedia content and services, congestion at various points on the network has caused much frustration. This has increased interest about pricing models, which charge people based on the marginal costs of their activities. However, others challenge this approach and promote maintaining the flat-rate pricing structure which has been so successful in spurring Internet growth. The goal is to allow more flexibility, so that network congestion is addressed without deterring use.

If the Internet is not congested, the marginal cost of sending an extra packet is essentially zero. However, when the network is operating at near capacity, bandwidth becomes a scarce resource. Congestion can impose a social cost, reflecting delays, interruptions and lost information.

Under the current flat-rate pricing system, users pay a flat fee to their Internet service provider for a given amount of connection time, and there may be an additional charge for time over and above the subscription package. This system does not consider peak-period usage and does little to mitigate congestion. Also, not all traffic needs to be treated the same. For example, file transfer tolerates zero errors, but can withstand delays. Interactive video can compensate for some packet

loss, but requires tight boundaries on delay. Furthermore, in the current system, users pay their average share of costs. Thus, low intensity users tend to subsidize high-intensity users.

One alternative is to have some form of usage-based pricing[8]. Users pay a portion of their bill for connection, and another portion for each bit sent or received. An analogy lies in some cellular telephone packages, where users only incur incremental costs at peak periods, while flat-rate pricing applies during non-peak times.

A downside of usage-based pricing is that there would need to be greater processing capacity at network routers than currently exists. In addition, the accounting costs and administrative overhead may be large (in telephony, billing overhead accounts for 50 percent of the phone bill, according to Bailey and McKnight). Users are also concerned that they will incur higher than anticipated costs. With a flat-rate subscription, consumers know what their local bill will be, and given this, they tend to use the infrastructure more. A good example of this is telephony in Canada. Canadians make greater use of telephones, with a flat-rate pricing structure, compared to Europeans, with per-minute charging.

Similarly, pricing structures on the Internet will strongly influence usage, both in terms of the total number of users, and in the behaviour of each user. Flat-rate pricing encourages people to spend more time exploring, which has spillover effects. Just as people browse in a shopping mall and buy items on impulse, the same is true online. More important, greater familiarity with the Internet will encourage increased economic activity, such as starting a small online business.

The Role of the Public Sector

Canada's public sector has long been a major economic player in delivering services to Canadians, and will continue to have enormous influence in sectors such as health, education, defence, the legal system and the provision of government information. Many of these areas will be enhanced by the expansion of the Information Highway. Governments can have an important role in creating demand for new services, through purchasing decisions, and in determining their information product needs in these areas. As the OECD notes:

> "Governments can have a further role in stimulating test-bed applications, and in the research and development, through a range of financial means, including low interest loans. As large potential users of information and communication services for their own internal needs and for services to the public, governments can assist in the development of new applications, stimulating their diffusion and assisting in familiarising the public with their use." (OECD, 1994b, Executive Summary)

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[8] Several variations of usage-based models have been suggested. One of the most popular in the economic literature is the Varian/MacKie-Mason "smart market" approach, where users assign a willingness to pay for immediate servicing for a given transmission. At congested routers, packets are prioritized based on these bids. However, users are only charged the price of the highest priority packet not admitted by the network (i.e. the market-clearing price). This price would be zero at non-peak times.

Through funding of CANARIE, which received IHAC endorsement for its Phase II business plan, the Canadian government has created an organization that brings together diverse networking interests from across the country. CANARIE runs a Technology and Application Development Program to stimulate the development of new Information Highway applications, with a current focus on health and education. It also runs the National Test Network, the largest Asynchronous Transfer Mode testbed in the world, reaching coast to coast in cooperation with regional test networks.

The need for a health information infrastructure was recommended by IHAC Phase I, and has been elaborated upon by a CANARIE document, *Towards a Canadian Health Iway*. For Canada, this will enhance the efficiency of the health system, by improving quality of service at the same time as lowering costs. One of CANARIE's recommendations was to promote demonstration and research projects in areas such as access and connectivity and assessing technologies for a "model information technology office."

Another emerging area is in applications related to education, which is particularly important as an investment in the skills required for Information Highway jobs. The Information Highway, through multimedia educational products, promises to revolutionize the way people of all ages learn. In the classroom, sorting out issues of how best to use the technology in cooperation with traditional methods is a complex matter. Distance education over high speed networks is poised to take off, as it builds upon an established market (e.g., correspondence courses), and will grow rapidly as more use is made as a means of corporate training.

Section Summary – Creating New Products and Services

This section has highlighted some of the current challenges and opportunities in providing new products and services for the Information Highway. Certainly, Canada's emphasis should be on the development of new products and services that can meet the needs of both domestic and global markets. However, there is still a great deal of uncertainty surrounding the markets themselves, as firms experiment with business models, and grapple with legal, financial and technological barriers. For the consumer, the Information Highway must be a low cost access point to products and services that add value to their lives. The public sector will continue to play a role in support of Information Highway activities and in the delivery of public services. However, money must be exchanged as a result of these new developments if we are to encourage the investment for real economic growth. In order to ensure that the employment potential of the Information Highway is realized, we must encourage the creation of new services and products with the same urgency and energy being applied to building the Information Highway.

The Jobs Question

The second policy challenge, employment and the Information Highway, has two related aspects: one is whether policy-makers can rely on the growth of the Information Highway to deliver a

sufficient increase in jobs; and the second is whether the jobs created will be high-skilled, high-paying jobs, or the low-skill, low-paying jobs now being called "McJobs." The technology and jobs issue is arguably the most pressing issue for ordinary, working Canadians, and this concern has been articulated in the media on several occasions. Gordon Moore, founder of Intel, expressed concerns that new technology and globalization are not only producing a growing gap between rich and poor, but are sowing the seeds of political instability.

While the question as to whether technology is creating or destroying jobs is not yet resolved, the debate has been engaged. Even in jurisdictions that espouse a policy stance based on job creation through technological development, it is acknowledged that public concerns exist, and that more research is required. On the second issue, the bifurcation of the labour market, there is a greater consensus, and all jurisdictions have identified this as a policy challenge.

Fundamentally the jobs and technology debate pivots on two questions. One, will the current technological shift repeat the historical pattern where the number of jobs created exceeds those eliminated, or is this an unprecedented shift, where the pattern breaks down and without intervention, the Information Highway will bring significant overall job losses? Secondly, even if we are convinced that there will be net job gains with the Information Highway, the historical pattern is that many must pay an enormous cost stemming from difficulties during the transition period. Economist Paul Krugman notes: "If history is any guide, it may be decades before the fruits of a better technology are fully reflected in higher wages." Are there alternative means of managing this transition to decrease and spread those costs, thereby increasing both the benefits from, and the acceptance of, the Information Highway?

Canada and the Information Highway Advisory Council Phase I

As noted above, the overriding view of the IHAC and the Canadian government to date has been that while the technology will invariably create winners and losers, its overall impact will be to stimulate economic growth and job creation. However, other views were expressed during IHAC Phase I, and government policies since then have addressed the concerns being raised regarding the overall employment impacts of the Information Highway, and more specifically, the changes that will occur in the nature of work.

Impacts of the Information Highway on Employment and the Workplace by Goss Gilroy & Associates Ltd., and commissioned by the Access and Social Impacts Working Group of the IHAC, argues that the technological changes promised by information technology are essentially unstoppable, but that it is society's response to the technology that will determine the technology's ultimate impact. The report suggests active measures to shape that response, and provides 69 broad-ranging recommendations. Some aspects of the report were controversial, and many of its recommendations were not endorsed by the full IHAC, but they were raised in the Minority Report.

The Minority Report voices disagreements on some of the key economic assumptions of the Final Report and provided an alternative strategy to address employment and workplace issues. Noting the current levels of unemployment in Canada and OECD countries and the accelerating pace of information technology in reducing employment, it cites the work of Jeremy Rifkin as well as the analysis and conclusions of the Goss Gilroy Report, to support its ten recommendations. They promote a strong government role in job creation, monitoring social and workplace impacts of the Information Highway, and in implementing legislative change to address some of these issues. It also advocates international cooperation on these issues, particularly endorsing social charters among trading partners to promote social policies abroad and ensure a level playing field.

The government has followed up on some of these issues, and indeed the extension of IHAC to its second term provides an opportunity to revisit these concerns. In terms of the impact of the Information Highway on the workplace, the Steering Committee on Workplace Issues and Lifelong Learning will be the focal point of IHAC's phase II work. Parallel to IHAC's work is also the Minister of Labour's Collective Reflections on Workplace Issues and Lifelong Learning to which the IHAC is providing input, and the National Forum on the Information Highway and Workplace Issues, as well as ongoing changes to the Canada Labour Code. All of these exercises will provide an opportunity to reflect on the issues raised in the Minority Report, and to engage the policy debate and discussion.

The trend towards increasing wage disparities has also been identified as a policy concern in Canada. The Policy Research Committee of the Privy Council Office, in its report "Growth, Human Development, Social Cohesion" notes that from 1989 to 1993, there was an 8.5 percent increase in wage income inequality as measured by the Gini coefficient, although this has been effectively mitigated by the effect of current government transfer payments. There is also a consensus that technological change will adversely affect unskilled workers. A recent Canadian study found that employment opportunites for unskilled workers are disappearing in many sectors, particularly those that are intensive users of computer-based technology. The study further suggests that even many of the jobs in traditionally low-skill sectors may disappear as these sectors shift adopt information technologies. Various policy options, such as increasing retraining options, are now being explored.

Other Jurisdictions

Concerns about employment and workplace issues have been raised in other industrialized countries. Steven Roach, head of Morgan Stanley, is distressed that "the once tight linkage between trends in productivity and real wages in the US economy appears to have broken down." The US government supports the notion that technology improves overall employment conditions, but also acknowledges the need to address the needs of workers affected by technology:

> "Rapid technological change has depreciated the value of many workers' skills. Even with wide access to training opportunities, some workers nay continue to

> find it difficult to maintain a decent standard of living. But just as it is futile to resist technological change, writing welfare cheques is at best a short-term solution. Social cohesion demands that those who are willing to work hard and 'play by the rules' must be able to live decently." (American National Position Paper for the G7 Employment Conference in Lille, France, April 1-2, 1996)

Emphasis on the employment impacts of the Information Highway is much greater in Europe, which has been mired in the same "jobless growth" seen in Canada during the most recent expansion. The European Council's High Level Experts Group on the Information Society endorses the position that there will be new jobs created by the information society, but identifies concerns that the service sector, which has traditionally absorbed workers displaced by technology, may also feel the impact of information technology. In the short run, their report notes that the job losses from the deregulation and privatisation of telecommunication operators "might involve substantial employment displacement."

The 128-member Information Society (IS) Forum's 1996 report raises the employment issue even more forcefully. It identifies two main questions: "Will these technologies not destroy more jobs than they create?" and "[w]ill the complexity and the cost of the new technologies not widen the gaps between industrialised and less developed areas, between the young and the old, between those in the know and those who are not?"

The IS Forum recommends that the EC "[i]nvestigate the particular sources of job creation in Europe resulting from the Information Society, and the measures needed to maximise it, and coordinate a set of national analyses and actions to demonstrate the ability of the Information Society to create jobs." The recommendations also suggest "identifying the best examples of job creation linked to the new technologies" and assessing and promoting best practices. Finally they ask for "the development of a coherent conceptual framework by mandating a small team of economists and experts to analyse the economics of the Information Society, its functioning, potential and drawbacks." All these EC initiatives raise social cohesion as a concern, noting that information technology could exacerbate the gap between haves and have-nots.

The OECD, in its *Technology, Productivity and Jobs* report argues that the ultimate employment impact of the Information Highway will be positive, and advocates policy to accelerate its implementation. Nevertheless, it identifies several challenging new trends, such as: persistent "stop and go" economic growth; the polarization of costs and benefits of technological change; increased labour market turbulence; greater instability in the business environment; the lack of education increasingly leading to unemployment or lower relative wages; and, that lengthening the period of formal education is less and less of a guarantee of finding well-paid jobs. The OECD also raises concern about the "growing danger of a new duality in society between info-connected haves and info-excluded have-nots that would lead to the social exclusion of the latter. The challenge for governments is, by maintaining social cohesion, to ensure the long-term sustainability of the new emerging knowledge-based growth model."

From this overview of Canada and other jurisdictions, it becomes clear that economic issues beyond the initial prescriptions of creating a competitive marketplace and encouraging the rapid development of the Information Highway have gained official attention. While there appears to be consensus regarding the positive employment of the Information Highway, all express unambiguous concern regarding the potential impact of technology on the divergence of wages in the economy. Further, at least in the case of Europe, there is a call for more study to provide convincing evidence that the Information Highway will not lead to net job losses in the short and medium run.

Alternative Views

Some commentators and the popular press have taken employment concerns further, raising strong doubts about the quantity and quality of jobs that will be provided by the Information Highway. On the first issue, as to whether the Information Highway will deliver a net increase or decrease in employment, there is continuous and perhaps growing concern expressed from various quarters that this may not be the case, and that the Information Highway could well be accelerating our problems with unemployment, rather than just a temporary transition. Even more moderate voices from the business community have expressed concern. John Sculley, former head of Apple Computers, says the destabilization of work will be the biggest social issue of the next 20 years. Management guru Peter Drucker argues that the disappearance of labour as a key factor in production will be "the unfinished business of capitalist society."

The work of Jeremy Rifkin is by now familiar to most people concerned with the technology and employment issue. His views have been cited in the Minority Report and most recently by the Premier of British Columbia. Rifkin argues that information technology is not like other technologies, because all sectors are affected by the labour reducing effects, and so no new sector can expand to absorb the majority of the displaced workers. This is exacerbated by the pace of technological development, and the fact that the technology allows labour to be moved to other jurisdictions where the cost of labour is lower.

Rifkin concludes that we are moving to a world without the abundance of jobs as we have known them. This need not be a gloomy scenario, as jobs, in their current form have only existed since the Industrial Revolution. Thus, Rifkin raises the question of "how we can ensure that the productivity gains of the Information Age are shared equitably." Rifkin emphasizes the need to fully debate these issues, noting: "Until now, politicians and economists have steadfastly refused to entertain a discussion of how we prepare for a new economic era characterized by the diminishing need for mass human labour."

More strident views are also beginning to gain attention, such as those of Ian Angell, of the London School of Economics:

> "Fundamental changes in the nature of work are taking place, changes as profound as when agricultural workers left the land for the cities and the whole fabric of

> society mutated. Now work is leaving the office and the factory for cyberspace ... Today, productivity is delivered by a technology needing only a few machine minders. National economies can no longer grow themselves out of unemployment. Growth has been uncoupled from employment... We are entering an age of hopelessness, an age of resentment, an age of rage."

Angell's views are expressed with colourful hyperbole, but the trends he identifies are ones that concern many, though few take such an apocalyptic view. Canada has produced its own critics of the Information Highway, notably Heather Menzies and David Noble. Both posit a gloomy future where technology is seen as putting many out of work, others have dehumanising McJobs, and a small elite gain access to the benefits of the Information Highway. Their prescriptions are a "call to arms" for working people to resist the imposition of new technology endorsed by management, politicians and unions alike.

In the media, the critical views expressed by these and like-minded individuals are being seen regularly, alongside the opinions of many who adopt a more sanguine perspective. But besides being a trendy media issue, some organizations and jurisdictions have begun to examine and propose measures to specifically address the employment issue. This suggests a willingness to be innovative in labour market frameworks, most often by a shortening of hours of work, encouraging early retirement and periodic sabbaticals.

Increasingly shorter work weeks are nothing new, as increased leisure time has been a benefit of strong economic performance. Canadians no longer work 56 hours a week, as they did in 1950. The Quebec government is considering pushing further, suggesting a reduction in the work week for the public sector to 32 hours from 35, with a corresponding reduction in salary. It is also exploring reducing the standard work week from 44 to 40 hours, job-sharing, and a payroll tax break for firms that add employees. Similar discussions are now taking place in British Columbia, again with particular emphasis on the public sector. In France, government officials are also looking at forgiving the payroll taxes for employers who voluntarily reduce their work week.

In the private sector, companies like Hewlett-Packard in France and BMW in Germany have reduced their work week while continuing to pay workers at the same weekly rate. In exchange, the workers have agreed to work shifts, allowing the new high-tech plants to operate on a 24-hour basis, thereby increasing the productivity of the capital invested in the plants.

Amongst the benefits touted by proponents of such proposals are a reduced burden to the state to care for unemployed individuals who will be hired to take up the slack, greater social equity, and improved domestic consumer demand from those who move back into the workforce.

Jobs and Technology – Demand Impacts and Other Considerations

The debate on technology and jobs is quite contentious, reflecting the underlying uncertainty as to the ultimate impacts of information technology. At present, employment levels have not improved

substantially in most parts of the world, despite the impressive gains in technology. While many areas of high technology are experiencing impressive job gains, in some high profile cases high technology sectors have lost jobs during periods of expansion. Outside the high technology sector, there have been many instances where technology has led to decreases in employment.

This uncertainty with respect to technology and jobs is doubly disturbing because a great deal is at stake: in our society jobs are the primary source of purchasing power, thereby allowing individuals to have access to goods and services. Jobs are often a critical element in determining personal self-worth and social identity.

Employment is also critical in sustaining the economy, for it completes the economic circle between producers and consumers. Even Henry Ford implicitly acknowledged this when he advocated paying higher wages to his workers, so that they could afford to buy the cars they were producing. Yet average family incomes have declined, falling from $58 000 per year to $55 000 from 1989 to 1996, according to *Report on Business Magazine* (Dec. 1996). Indications are that consumer spending has been sustained by debt, but this is no longer sustainable, with consumer debt at a record high of 91.5 percent of disposable income, according to Statistics Canada. From 1983 to 1996, average household debt rose from $26 000 per year to $43 000.

Just as high levels of employment can lead to a virtuous spiral of strong demand, increasing output and increased demand for labour, adding up to steady economic growth, it is also possible that low employment can weaken demand, decrease output and thus decrease demand for labour. The result could be an ongoing economic recession, or even an extreme downward spiral of the sort witnessed during the Great Depression. Could a technology-driven decrease in demand for labour precipitate such a decline? Even if it is not considered a high probability outcome, arguably we should give some attention to how such a crisis would be addressed, particularly in an era where concern for deficits has weakened public capacity to stimulate demand.

Consumption of information goods requires more than income, but also time to absorb and enjoy them. Paradoxically, leisure is decreasing for many of the high-paid knowledge workers, whose hours of work are increasing, while those without work have nothing but leisure time. According to Statistics Canada, for both men and women, the proportion of standard 35-40 hour work weeks declined from 1976 to 1995, while both shorter and longer work weeks increased. An Angus Reid poll from early 1996 found that 60 percent of Canadians said that over the past five years, their leisure time has shrunk. A situation where those with money have little time, and those with time have little money is not auspicious in terms of developing markets for the knowledge-based economy.

However, redistribution of work is not a simple undertaking. For many, personal financial considerations such as high debts, make the option of working less with a commensurate drop in income unattractive. Indeed a recent study conducted by Human Resources Development Canada found very limited support by the Canadian public for a mandatory reduction in work time. While such a reduction without a loss in pay would no doubt be more attractive to Canadian workers,

more work needs to be done to understand how such a policy could be funded, and to assess its impacts on the market place and economy.

A similar demand-side analysis can be applied to the issue of diverging incomes between high and low-skilled workers, now prevalent in most developed countries. There is growing evidence that technological shifts could add to income polarities. This increased income polarity that will result may be considered an issue of social equity, and not a suitable topic for this paper. However, if (as most of the views noted reflect), this disparity can start to affect social cohesion, then this is an economic issue, for a functioning society is a prerequisite for a functioning economy. Research indicates that there is a high correlation between social stability, an effective public sector, and economic performance, and some recent work suggests that the former causes the latter. If this is indeed the case, then we have strong economic reasons to address these concerns.

The difficulty with these discussions is the fundamental uncertainty associated with the various options. What is the appropriate response to uncertainty regarding the net impact of the Information Highway on employment levels? Few people expect their house to burn down, and would not expend vast sums preparing for this calamity. However they do find it prudent to purchase fire insurance. What sort of fire insurance can we adopt to prepare for Rifkin's scenario? Certainly policy research is an inexpensive form of insurance. Active discussion and debate are other low cost activities that will help both to refine our assessment of the likelihood of the Rifkin world developing, as well as provide an opportunity to assess the sorts of policy alternatives that can be offered. Although many critics are quite thin in the area of developing options, Rifkin's prescriptions include: providing income vouchers for work in the "social sector," funded by a tax on high technology goods and service; elimination of payroll taxes to encourage more employment rather than more overtime; encouraging profit-sharing plans; and providing tax credits for volunteer work in the "social sector." If the opportunity presents itself to experiment with alternative policies to address the jobs issue, and they are being developed in the context of other policy priorities, then this might be worth encouraging.

Chapter Summary and Discussion

This section has identified a spectrum of views and policy challenges being generated from within governments and by outside commentators and critics. With the exception of some of the more radical views expressed, many of the views are not in contradiction with the fundamental goals of advancing the Information Highway, providing the benefits of the new technology, allowing the firms and industries involved to prosper, and ensuring countries maintain a competitive position in the new knowledge-based economy. Rather, they identify new economic opportunities to be seized, and assess some possible down sides to the overall revolution that is taking place in information technology and telecommunications. The views challenge us to find ways to embrace new economic opportunities, and challenge us to develop mitigating measures to the unintended negative impacts of the technology.

On the first issue, creating demand for new products and services, we can advance the sphere of policy concerns and private sector and government action beyond the initial focus on infrastructure and the market environment. There are real growing pains associated with the shift to a knowledge-based economy, and issues, such as facilitating electronic commerce, measuring and valuing the economic activity on the Information Highway, and encouraging new content services, that must be addressed.

On the second issue, we face varying opinions on whether the Information Highway will lead to a net increase or decrease in the number of jobs in society, and the evidence seems inconclusive. This uncertainty does not imply any change in current policy, but it may indicate that prudence requires us to further engage the issue with more study, open debate and discussion, and even support for the modest policy experimentation that is being conducted to address broader labour market concerns.

AN INFORMATION HIGHWAY FOR JOBS AND GROWTH

This paper has addressed the contribution of the Information Highway to economic development and employment in terms of the dynamics of markets, innovation and technology diffusion. It leads to three major conclusions that are relevant to the role of the Information Highway in the transition to a knowledge-based economy. First, the emphasis on creating an environment to promote investment in infrastructure remains vital for economic growth and is supported by the policies followed in other jurisdictions. We must continue to pursue these policies in order to ensure that Canada reaps the full benefits of the Information Highway, and maintains its competitive position. The second is that more needs to be done to foster the development of markets for new Information Highway products and services, which are the economic base for the new economy. This would entail policy and other measures aimed at stimulating both the supply and demand of Information Highway services, applications and content, that will translate into wealth and employment. The third is that, as with all new technologies, there are some unintended negative consequences which may occur, and that we need to determine if mitigating measures are required, and if so, what they are.

On the first theme, Canada and IHAC are committed to the agenda as defined by the September 1995 Final Report and *Building the Information Society*. This must be continued with considerable urgency, for the pace of technological development means that to hesitate is to be left behind. *Preparing Canada for the Digital World*, the Council's Phase II Report, will provide a detailed update on that agenda and Canada's progress to date.

A similar urgency is attached to the second goal of developing demand for new products and services. Building on our understanding of the dynamic of technology diffusion, and on the insight that job creation ultimately is linked to creating goods that expand demand, both government and the private sector must work together to ensure that the marketplace to exchange knowledge-based goods on the Information Highway functions effectively. This will involve ensuring that effective mechanisms to capture and measure the real value being generated by the technology are put in place, and that the content and service industries are given a favourable environment to grow and prosper.

It will also mean directing our attention to key sectors of the information economy, to identify the barriers and opportunities that must be addressed to ensure success. The Steering Committee on Economic Growth and Job Creation has undertaken such work in parallel, under its micro agenda, and has looked at the Information Highway and the areas of: health; education and learning technologies; and SMEs and electronic commerce.

Finally, on the issue of possible negative employment impacts of information technology, the IHAC encourages further policy research in this area, ongoing public discussion and debate, and the exploration of policies that provide alternative mechanisms to deal with the possibilities that

the number and quality of jobs generated may not meet expectations. Both the success of the Information Highway, as well as our broader economic well-being, are at stake.

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