The Knowledge Economy

a submission to the New Zealand Government
by the Minister for Information Technology's
IT Advisory Group

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Foreword

In today's information age knowledge has become the gold standard. If New Zealand is to prosper in the third millennium it is vital that we understand the implications of this change.

But time is short. Prices for our commodity exports are in decline and we face tight competition for markets. It is unlikely that the traditional foundations of our economy alone – farming, forestry and fishing – can deliver the level of growth needed for our future well being. If we don't change the way we compete in the global economy our way of life and standard of living are at risk.

Over the past 15 years New Zealand Government policy has focused on developing a modern open competitive economy in the expectation that this would encourage better use of our productive resources. These reforms have by and large been successful. Despite this, not enough of New Zealand's productive capacity has shifted to the knowledge-based industries that are delivering the fastest growth rates world-wide.

Nevertheless New Zealand has some excellent examples of knowledge-rich enterprises, particularly in electronics, software, biotechnology, banking, fashion design, filmmaking, education and some agricultural products. These are substantial achievements but there are simply not enough of them. This report looks at what more needs to be done, particularly in those areas where government continues to play a significant role in the economy.

The foundation stones of the knowledge economy are human ingenuity and skill and a commitment to innovation through research and development. The New Zealand Government already invests heavily in the education system and through its funding of well over 60% of the measured research and development carried out in New Zealand. Are we getting the value we need from this investment?

ITAG's view is that the future of our country depends on the ability of the private sector to generate jobs and wealth and government's role is to minimise impediments to this. The issue today is for the Government to focus on ensuring that its current interventions – such as in education and R&D – are as focused as possible on taking New Zealand forward into the knowledge age.

This report provides a well-researched independent view of factors that lead to the effective development of a knowledge economy. As part of a growing debate on our future economic development, it provides options for the Government to consider in the ongoing discussions about New Zealand's future directions. It is a contribution from the IT sector to the growing realisation that New Zealand has a significant opportunity to become a knowledge economy – an opportunity we cannot afford to pass up.

Ralph Norris
Chair, Information Technology Advisory Group (ITAG)

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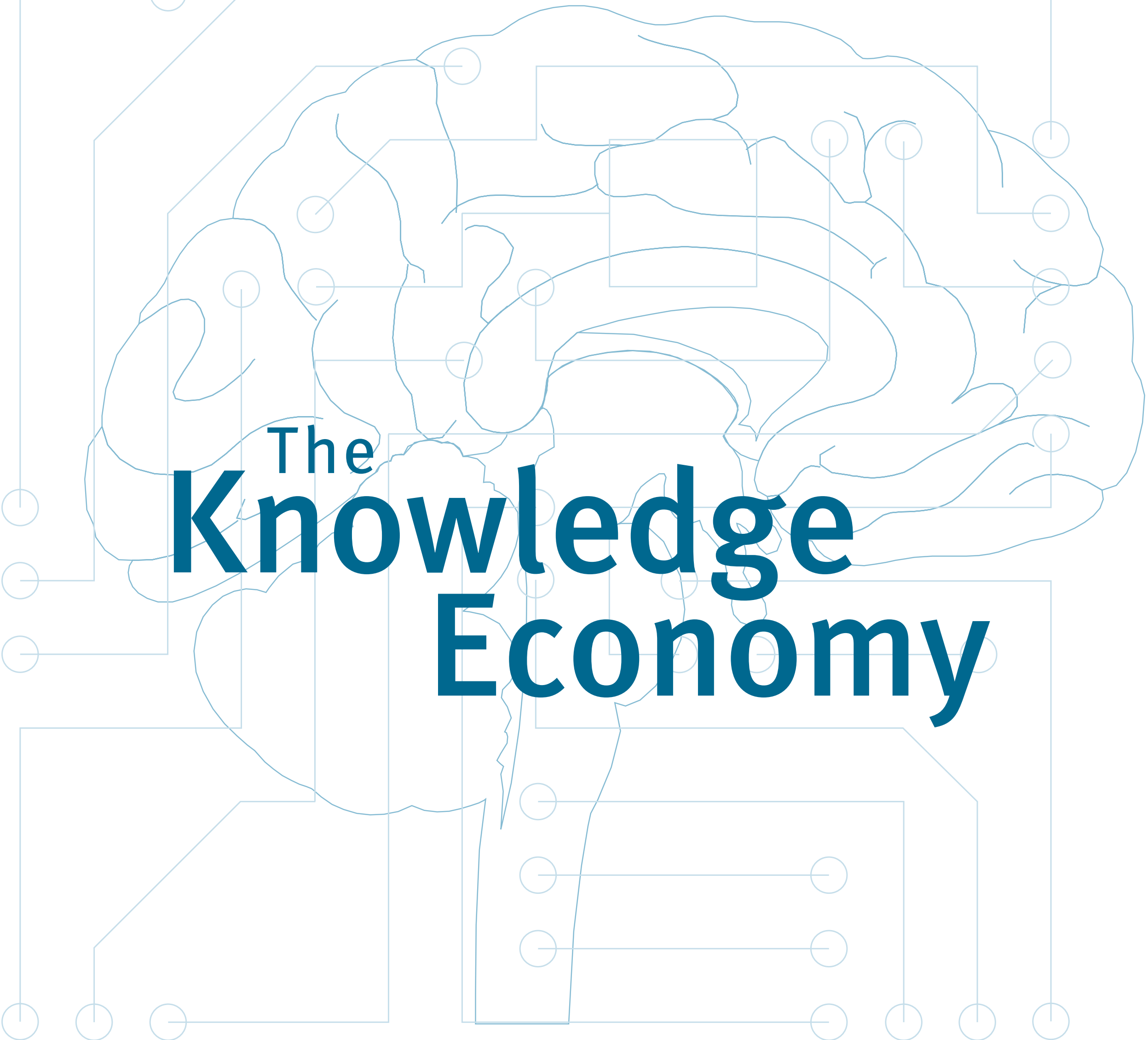


The Knowledge Economy

Executive Summary

The Information Age is upon us. The cycle of technology development and implementation is accelerating. The number of Internet users world-wide continues to grow steeply. More than 50 per cent of Gross Domestic Product (GDP) in the major OECD economies is now based on the production and distribution of knowledge. We are leaving the Industrial Age behind and moving into the Information Age.

In the US, Australia, the United Kingdom, Canada, Finland, and Ireland, the growth of the Internet and other related new technologies have become the catalyst for the creation of ‘knowledge economies’.

The new information and communication technologies (ICT) have created global markets for goods and services.

Countries that have encouraged their people through education and life-long learning and by investing heavily in research and development (R&D) are well positioned to take advantage of these new global markets. Australia, Finland, Ireland, Canada, Singapore, and the United States are countries which have embraced the knowledge economy (some still with a strong commodity sector), and are experiencing strong GDP growth as a result. There is much we can learn from them.

Along with globalisation has come the death of distance. Thanks to the Internet, New Zealand is no longer remote from the rest of the world. But New Zealand’s economy is still too dependent on producing commodities for export. While efforts over the last fifteen years to diversify markets have been very successful, we still need to expand our limited range of products. We must take the next important step and transform New Zealand from a pastoral economy into a knowledge-driven economy.

For New Zealand, the Internet is the modern equivalent of the freezer ship that revolutionised our economy last century.

Finland in particular provides an excellent model for New Zealand to follow. It has transformed itself from a commodity-based economy to one that has embraced new technologies. The government has spent a lot of money on education, making information technology a key component of the school curriculum and producing large numbers of technical graduates. Finnish companies have invested heavily in research and development. High-technology as a percentage of Finnish GNP has increased fivefold in ten years.

New Zealand has many of the prerequisites needed for the Information Age, such as a good technological infrastructure and a culture of innovation. Already 40 per cent of households have a computer. Internet usage is very high. While traditional statistics do not enable us to say how much of New Zealand's GDP is created by knowledge, the IT sector, a critical foundation for utilising knowledge, accounts for 7 per cent.

We are weak in these key areas:

- the place of information and communication technologies (ICT) in education, the low number of graduates we produce in technical disciplines, and more widely, ensuring that all teachers and students are ICT-literate
- immigration policy, especially in attracting suitably qualified immigrants, including New Zealanders currently living abroad
- investment in R&D, especially by the private sector
- narrow export mix, with a low percentage of high-technology exports
- venture capital and entrepreneurship, where our would-be entrepreneurs often lack the necessary business skills, and there is only a small local venture capital market
- strategic vision, especially in championing the development of a knowledge economy, and communicating it to all New Zealanders.

If New Zealanders do not seize the opportunities provided by the knowledge economy, we will survive only as an amusement park and holiday land for the citizens of more successful developed economies.

Beating the Argentine disease: a call to action

> The next information revolution is well under way... It is not a revolution in technology, machinery, techniques, software, or speed. It is a revolution in CONCEPTS...
> *(Drucker, 1998).*

We have a good foundation to be successful in the global economy

New Zealanders have some reason to be cautiously optimistic as we approach the third millennium. Since the mid 1980s, when New Zealand embarked on a thorough programme of economic reform, public sector debt has shrunk from more than half of GDP to about a quarter of GDP, saving taxpayers billions in interest payments. Interest rates are now at their lowest level in 30 years. As of March 1999, the economy had 284,000 more jobs than in 1991 (Statistics New Zealand 1999a). Energy reforms, removal of tariffs, tax reforms, and parallel importing have put money into the pockets of businesses and households. New Zealand has slashed its public spending from 41 per cent of GDP in 1990 to 35 per cent in 1997-1998. Our labour markets are flexible and we have one of the most open, transparent and unregulated economies in the world.

We must move quickly to become a knowledge-driven economy

But there is a darker side to our present situation that many in business and government fail to recognise. While we have stopped the inexorable downward slide, there is a new challenge ahead of us. Our competitors are playing a very different game, one whose rules New Zealanders have yet to learn. The efforts of the last fifteen years will be for naught unless the next important step is taken: the conversion of New Zealand from a pastoral economy into a knowledge-driven economy.

New Zealanders have not yet fully recognised that the Internet is the modern equivalent of the freezer ship that revolutionised our economy last century. As we enter the twenty first century, the Internet will be our key vessel for reaching global markets.

Otherwise we could become an "also-ran"

The decline of a once prosperous economy is known as 'the Argentine disease'. Although these days Argentina is considered to be a developing country, in 1929 it was as rich as any large country in Europe. Fifty years ago New Zealand exported most of its primary produce to Britain and the country rode to prosperity on the back of the sheep. We had the third highest per capita income in the world. Today we find ourselves ranked just above Greece and Portugal, towards the bottom of the European OECD countries (OECD, 1998). Have we caught the Argentine disease? Why have we dropped so far?

The answer is that New Zealand is still playing the game of commodity exports. Although we have worked hard to find new export markets for our commodity products, and to increase our exports of value-added products, our income is still subject to the vagaries of commodity prices. We have not yet made the transition from an agricultural economy to one based on information, where knowledge is a significant component of products.

We must become a "knowledge-export" platform

We have not yet learned to see our country, as our competitors now see theirs, as a 'knowledge export platform'. Our competitors – Ireland, Singapore, Australia, United Kingdom – have done so, and they are beating us in the game of economic prosperity. If we do not heed the call, we will fall further in the rankings, perhaps as far down as Slovenia and Hungary, countries that aspire to our standard of living. In ten years' time economists may characterise New Zealand as one of those unfortunate countries that failed to make the transition to the new economy, and count it among the also-rans. They may call it 'the New Zealand syndrome'.

> The nations that will be successful in the information revolution may be large or small, and are unfettered as to hemisphere. Assuredly, however, they will have invested in the critical information, computer, social and Internet infrastructures
> *(McGovern, 1998).*

What is the Knowledge Economy?

For countries in the vanguard of the world economy, the balance between knowledge and resources has shifted so far towards the former that knowledge has become perhaps the most important factor determining the standard of living – more than land, than tools, than labour. Today's most technologically advanced economies are truly knowledge-based.
World Development Report, 1999

For the last two hundred years, neo-classical economics has recognised only two factors of production: labour and capital. Knowledge, productivity, education, and intellectual capital were all regarded as exogenous factors – that is, falling outside the system. New Growth Theory is based on work by Stanford economist Paul Romer and others who have attempted to deal with the causes of long-term growth, something that traditional economic models have had difficulty with. Following from the work of economists such as Joseph Schumpeter, Robert Solow and others, Romer has proposed a change to the neo-classical model by seeing technology (and the knowledge on which it is based) as an intrinsic part of the economic system. Knowledge has become the third factor of production in leading economies. (Romer, 1986; 1990)

Technology and knowledge are now the key factors of production

Romer's theory differs from neo-classical economic theory in several important ways:

- Knowledge is the basic form of capital. Economic growth is driven by the accumulation of knowledge.
- While any given technological breakthrough may seem to be random, Romer considers that new technological developments, rather than having one-off impact, can create technical platforms for further innovations, and that this technical platform effect is a key driver of economic growth.
- Technology can raise the return on investment, which explains why developed countries can sustain growth and why developing economies, even those with unlimited labour and ample capital, cannot attain growth. Traditional economics predicts that there are diminishing returns on investment. New Growth theorists argue that the non-rivalry and technical platform effects of new technology can lead to increasing rather than diminishing returns on technological investment.
- Investment can make technology more valuable and vice versa. According to Romer, the virtuous circle that results can raise a country's growth rate permanently. This goes against traditional economics.
- Romer argues that earning monopoly rents on discoveries is important in providing an incentive for companies to invest in R&D for technological innovation. Traditional economics sees 'perfect competition' as the ideal.

Enhancing human capital is critical for GDP growth

But sustained GDP growth doesn't just happen. In order to make investments in technology, a country must have sufficient human capital. Human capital is the formal education, training and on-the-job learning embodied in the workforce.

What is the knowledge economy? 'A knowledge-driven economy is one in which the generation and exploitation of knowledge play the predominant part in the creation of wealth' (United Kingdom Department of Trade and Industry, 1998). In the industrial era, wealth was created by using machines to replace human labour. Many people associate the knowledge economy with high-technology industries such as telecommunications and financial services.

More than 60% of US workers are knowledge workers

Knowledge workers are defined as 'symbolic analysts', workers who manipulate symbols rather than machines. They include architects and bank workers, fashion designers and pharmaceutical researchers, teachers and policy analysts. In advanced economies such as the US, more than 60 per cent of workers are knowledge workers.

What is knowledge?

> He who receives an idea from me receives instruction himself without lessening mine; as he who lights his taper at mine receives light without darkening me.
> *Thomas Jefferson*

Unlike capital and labour, knowledge strives to be a public good (or what economists call 'non-rivalrous'). Once knowledge is discovered and made public, there is zero marginal cost to sharing it with more users. Secondly, the creator of knowledge finds it hard to prevent others from using it. Instruments such as trade secrets protection and patents, copyright, and trademarks provide the creator with some protection.

Know-why and know-who matters more than know-what

There are different kinds of knowledge that can usefully be distinguished. *Know-what*, or knowledge about facts, is nowadays diminishing in relevance. *Know-why* is knowledge about the natural world, society, and the human mind. *Know-who* refers to the world of social relations and is knowledge of who knows what and who can do what. Knowing key people is sometimes more important to innovation than knowing scientific principles. *Know-where* and *know-when* are becoming increasingly important in a flexible and dynamic economy. *Know-how* refers to skills, the ability to do things on a practical level.

Knowledge gained by experience is as important as formal education and training

The implication of the knowledge economy is that there is no alternative way to prosperity than to make learning and knowledge-creation of prime importance. There are different kinds of knowledge. 'Tacit knowledge' is knowledge gained from experience, rather than that instilled by formal education and training. In the knowledge economy tacit knowledge is as important as formal, codified, structured and explicit knowledge.

According to New Growth economics a country's capacity to take advantage of the knowledge economy depends on how quickly it can become a 'learning economy'. Learning means not only using new technologies to access global knowledge, it also means using them to communicate with other people about innovation. In the 'learning economy' individuals, firms, and countries will be able to create wealth in proportion to their capacity to learn and share innovation (Foray and Lundvall, 1996; Lundvall and Johnson, 1994). Formal education, too, needs to become less about passing on information and focus more on teaching people how to learn.

Life long learning is vital for organisations and individuals

At the level of the organisation learning must be continuous. Organisational learning is the process by which organisations acquire tacit knowledge and experience. Such knowledge is unlikely to be available in codified form, so it cannot be acquired by formal education and training. Instead it requires a continuous cycle of discovery, dissemination, and the emergence of shared understandings. Successful firms are giving priority to the need to build a 'learning capacity' within the organisation.

The importance of intellectual capital

Intellectual capital is a firm's source of competitive advantage

To become knowledge driven, companies must learn how to recognise changes in intellectual capital in the worth of their business and ultimately in their balance sheets. A firm's intellectual capital – employees' knowledge, brainpower, know-how, and processes, as well as their ability to continuously improve those processes – is a source of competitive advantage. But there is now considerable evidence that the intangible component of the value of high technology and service firms far outweighs the tangible values of its physical assets, such as buildings or equipment. The physical assets of a firm such as Microsoft, for example, are a tiny proportion of its market capitalisation. The difference is its intellectual capital.

How do we measure a firm's intellectual capital? How can a firm tell whether its knowledge assets have increased or diminished over a certain period of time? According to Strassman (1998), intellectual capital is what is left over after suppliers, employees, creditors or shareholders and the government have been paid, and obsolete assets replaced. There are other approaches, including those of Sveiby (1997) and of Stewart (1997). One tool that is now widely used by US companies is Kaplan and Norton's Balanced Scorecard, which combines financial with non-financial measures, such as internal business processes, learning and growth, and various customer-related measures (Kaplan and Norton, 1996). Competency models seek to define and classify the behaviours of successful employees and calculate their market worth, while a business worth approach seeks to consider the value of information and the costs of missed or under-utilised business opportunities.

The importance of ICT

ICT release people's creative potential and knowledge

What about information and communication technologies (ICT)? ICT are the enablers of change. They do not by themselves create transformations in society. ICT are best regarded as the facilitators of knowledge creation in innovative societies (OECD, 1996). The new economics looks at ICT not as drivers of change but as tools for releasing the creative potential and knowledge embodied in people.

However, the ICT sector has a powerful multiplier effect in the overall economy compared with manufacturing. A 1995 study of the effect of software producer Microsoft on the local economy revealed that each job at Microsoft created 6.7 new jobs in Washington state, whereas a job at Boeing created 3.8 jobs (Mandel, 1997). Wealth-generation is becoming more closely tied to the capacity to add value using ICT products and services. The value of accumulated knowledge within New Zealand is an important indicator of its future growth potential.

The new economics of information

The rate of technological change has greatly increased over the past thirty years. Three laws have combined to explain the economics of information (Gilder, 1994). *Moore's Law* holds that the maximum processing power of a microchip at a given price doubles roughly every 18 months. In other words, computers become faster, but the price of a given level of computing power halves. *Gilder's Law* – the total bandwidth of communication systems will triple every 12 months – describes a similar decline in the unit cost of the net. *Metcalfe's Law* holds that the value of a network is proportional to the square of the number of nodes. So, as a network grows, the value of being connected to it grows exponentially, while the cost per user remains the same or even reduces.

While Metcalfe's Law has been applied to the Internet, it is also true of telephone systems. Gordon Moore first formulated Moore's Law in the early 1970s. There can be no doubt that the cycle of technology development and implementation is accelerating and that we are moving inexorably onward, out of the Industrial Age and into the Information Age.

Globalisation

ICT open up global markets and foster competition

With the advent of information and communication technologies, the vision of perfect competition is becoming a reality. Consumers can now find out the prices offered by all vendors for any product. New markets have opened up, and prices have dropped. When businesses can deliver their products down a phone line anywhere in the world, twenty-four hours a day, the advantage goes to the firm that has the greatest value-addition, the best-known brand, and the lowest 'weight'. Software provides the best example: huge added value through computer code, light 'weight' so that it can be delivered anywhere at any time.

Competition is fostered by the increasing size of the market opened up by these technologies. Products with a high knowledge component generate higher returns and a greater growth potential. Competition and innovation go hand in hand. Products and processes can be swiftly imitated and competitive advantage can be swiftly eroded. Knowledge spreads more quickly, but to compete a firm must be able to innovate more quickly than its competitors.

Brands are critical. They strengthen consumers' trust in nations and their products

In a global marketplace where consumers are overwhelmed by choice, brand recognition assures their trust in both the tangibles and intangibles that a product will deliver. Like intellectual capital, brand equity can be hard to measure yet it may account for a significant proportion of a company's value. It is intangible in the sense that it often consists of customers' perceptions of the value they gain from using a product or service rather than any measurable benefit. A nation's brand can be as important (or more) as the firm's, and provide extra leverage for whichever firm's brand is attached to the actual product – Swiss watches, Scotch whisky, German cars, Japanese appliances, New Zealand butter.

New Zealand has powerful brands

The importance of *nation* brands, such as New Zealand's "clean, green", "Māori/South Pacific" and "young/innovative" brands, lies in their ability to add value by transcending the product yet being integrated within it – as recent fashion, children's literature, music and organic food export successes illustrate. Brand New Zealand has often been used to attract visitors. However, the Internet offers New Zealand companies the opportunity to leverage off 'brand New Zealand' as well as their company brand identity, for export purposes.

Small countries such as New Zealand have become dependent 'bidding economies' currying favour in globalised markets. Any small government that ignores these facts will be punished through capital flight and currency devaluation. Thanks to advances in information technology, markets (and the trans-national corporations that underpin them) act quite independently of their respective national political systems.

This has lead to the globalisation of capital. Capital continually circulates in search of maximum investment opportunities. Information technology has accelerated this process and made it more successful. It is no longer geography that determines the winners. Idea-driven innovation cycles in the knowledge economy determine an economy's position in the global hierarchy. *The more innovative and intelligent a business location is, the higher its rank in the ladder of global investment.*

Capital searches the globe for the best returns, looking for innovation

> Countries like... New Zealand are in far stronger positions to take advantage of the information revolution than they were to exploit the industrial revolution *(McGovern, 1998).*

Lessons for New Zealand

New Zealand companies need to better understand and use the concept of intellectual capital. They need to look at their products, processes and people, and assess and augment the amount of knowledge they possess. They must unlock the value of their hidden assets, such as the talents of their employees, the loyalty of their customers, and the collective knowledge embodied in their systems, processes, and culture. They must learn how to turn their unmapped, untapped knowledge into a source of competitive advantage.

Our people are a source of competitive advantage

For New Zealand, one of the single most important aspects of the Information Age is the 'death of distance' (Cairncross, 1995). Distance no longer determines the cost of communications. This will be one of the most dynamic shaping forces for New Zealand. Patterns of international trade, concepts of national borders, and the basis of decisions about where people live and work will be altered in ways that are only dimly imaginable.

The information age heralds the "death of distance"

In this new view, New Zealand is at the centre of the world. Our white-collar workers can compete on price and quality with those in London or California. New Zealand will be able to retain graduates who until now have emigrated in search of higher salaries. Work-related travel will decline. People will no longer have to live in cities to work; instead, they will be able to work from wherever they choose to live. ICT will enable New Zealand not only to overthrow the tyranny of distance but also to mitigate the disadvantages of our small population and low population density – at 13 people per square kilometre similar to that of Argentina and Finland (Statistics New Zealand, 1994; Collins Concise Atlas of the World). *New Zealand is no longer on the edge, but at the edge.*

New Zealand at the centre of the global economy

New Zealand's competitors in the knowledge economy

Many countries around the globe are racing to prepare themselves for electronic commerce and the emerging knowledge economy. Similar issues confront all: how best to reap the political, social, and economic benefits and how to avoid their risks. Nations respond to this new environment in different ways, as a consequence of their different cultures, national priorities, economic status, size, geography and population. No one model is perfectly transferable to New Zealand yet themes and patterns emerge.

All developed nations are our competitors

One of the defining characteristics of the knowledge economy is that it is truly global. Markets are no longer defined by, or limited to, national boundaries. In the past we have tended to construe our competition in straightforward terms: Ireland competes with us in terms of butter sales or Australia in lamb. The global nature of the knowledge economy changes the dynamics of competition. In the education market, for instance, New Zealand's competitors are found around the world. In consequence, here the term 'competitor' is used broadly, to include all developed nations with knowledge economy strategies.

What our competitors are doing?

Governments play a key role in creating vision and strategy

As we examined the policies of countries that are embracing the knowledge economy, we paid special attention to the role governments play in stimulating knowledge-intensive economies. They have all invested in implementing information societies and on-line economies. Most have created, and invested in implementing, vision statements that describe a future based upon changing economic and social development and the use of new technologies to achieve those goals. But there are also differences. The United States, Canada, and Australia have articulated broad principles. The European Union has concentrated on pilot projects to support industry and to promote social cohesion. Many countries in East Asia have set target dates and investment projections. The UK, like New Zealand, has focused on infrastructural competition; the US has emphasised more competition in services; while Singapore has not emphasised competition at all. The US has used the new economic reality to stimulate wealth creation while the EU has emphasised regional development. Japan's approach is to try to reverse its economic downturn by using information technologies.

In Table 1, at the end of this section, we summarise the various strategic approaches that have been adopted by our competitors around the world. First we explore some examples in more depth.

Australia

In 1998 Australia was one of the world's fastest-growing economies, with GDP growth of 4.9 per cent. Part of this success has to do with government and private initiatives that positioned Australia at the leading edge of technology, content development and innovative use of the Internet. These efforts are being co-ordinated by the National Office for the Information Economy to lift the awareness of the benefits of the on-line economy in the general community and the business sector.

Australia is well positioned to maximise the on-line economy

The number of Australian firms on-line recently doubled in less than 12 months. By January 1999, over 48,000 businesses had their own domain names hosted at Internet Service Providers (ISPs), with an additional 50,000 Web sites hosted in-house or at an on-line shopping directory or mall. There are now over 640 ISPs operating in Australia (Nua Internet Surveys, 1999).

Revenue from Australia's information industries in 1995-96 was A$47 billion. Australia represents only 1.2 per cent of global GDP but generates about 2.3 per cent of global activity in information industries. Seven thousand companies were created in the computing and telecommunications sectors during the last five years. Australia's per capita consumption of recent innovations is rated second only to the US, as is the sophistication of Australia's information industries. Information technology export receipts totalled A$4 billion per annum (National Office for the Information Economy, 1999).

Australia wants our IT workers

In employment, growth in information technology jobs rose by 46 per cent in the last ten years in Australia (compared with 16 per cent for all occupations). In late 1998 the unemployment rate for people with IT skills was only 2.7 per cent. Demand for IT workers is growing at 12 per cent per annum. Indeed, Australians are grappling with a shortage of IT workers. There are an estimated 30,000 unfilled positions in Australia and many warn that it will get worse. But the Australian IT industry has begun a national awareness programme and is developing 'centres of excellence' to deal with the growing high-tech skills shortage.

Federal and state leadership

Nowhere in Australia are these developments more visible than in the State of Victoria (Braim, 1998; Thomas, 1998; Riley, 1999). In 1996 the Victorian Government adopted an information technology and multimedia strategy, **Victoria 21**, to position the state to attract inward investment and create jobs in the sector. Initially seed-funded with A$200 million to support projects and policies, the goals of Multimedia Victoria are to make structural adjustments to the economy and to develop the information industries. Multimedia Victoria sought to show government as a model user, promote R&D and exports, generate jobs, and achieve 'brand recognition' of Victoria, Australia as a centre of excellence in the global digital economy. Lately it has worked with businesses to help them adopt electronic commerce. The intention is to have all government services available on-line by the end of 2001. A massive Internet training programme called **Skills.net** has brought more than 10,000 Victorians on-line in less than 18 months.

The results since 1996 have been the creation of 10,000 new jobs and some A$2 billion in inward investment (Multimedia Victoria, 1998). Victoria has attracted major industry players, established on-line delivery of government services, and developed a broad policy agenda, for example in data protection and electronic commerce.

While the Victorian example stands out, the Australian government as a whole has become pro-active in its attempt to accelerate these developments. It offers grants aimed at accelerating the adoption of e-commerce by small and medium enterprises, offers a tax incentive on private R&D investment, has capitalised the Innovation Investment Fund to expand the availability of venture capital (AusIndustry, 1999), and is committed to delivering all appropriate Commonwealth services on the Internet by 2001.

Finland

Finland is very like NZ and has transformed into a knowledge-driven economy

Finland is similar to New Zealand in many ways. A country of lakes and forest, with a low population density like New Zealand, Finland is distant from the rest of Europe. Once forestry played the same role in Finland's development that pastoral farming has played in ours. Now, despite experiencing output growth, forestry is less than 3 per cent of GDP (Ministry of Finance, 1998).

In the past fifty years Finland's agricultural population has declined from 70 per cent to 6 per cent. It has successfully changed gear and cut its reliance on producing primary commodities. High-tech industry as a percentage of the Finnish GNP has jumped fivefold in ten years. The result: Finland's GNP per capita has skyrocketed.

The Finns recognised that they had to begin playing by new rules. Structural dislocations and mass unemployment have been brought under control. Many of its agricultural firms have converted to the new knowledge industries. Nokia has come to symbolise Finland's high technology shift. Once a huge pulp and paper company, Nokia changed its business focus only in the late 1980s, but has become one of the world's leading electronics companies. The company now accounts for more than 15 per cent of the country's exports (Buwalda, 1998).

Government led with a clear strategy

How did the Finns do it? In the early 1990s an OECD study revealed that Finland had astonishingly high levels of information technology penetration and expertise yet lacked a clear strategy in these areas. In 1994, the Government, prompted partly by Finland having lost markets in the former Soviet Union, unveiled its national strategy, *Finland's Way to the Information Society* (Ministry of Finance, 1996), and backed it up by deregulating the telecommunications sector and launching programmes to stimulate the economy.

Private sector embraced new technologies and R&D

Finland's economy has diversified to embrace new technologies. To processing technology, manufacturing technology, energy, chemical technology, construction technology, and market knowledge, Finns are now adding ICT, environmental technology and biotechnology. These related technologies are becoming increasingly competitive in their own right and are largely immune to fluctuations in commodity prices for forest products (Buwalda, 1998).

Finland's innovative firms do not wait for handouts from their Government. While the world's top 300 companies spent an average of 4.6 per cent of sales on R&D, Finnish companies spent more than double the OECD average, at 10.4 per cent (*The Economist*, 1999a). One Finnish company alone, Nokia, spends more on R&D than New Zealand (Buwalda, 1998).

A "learning economy"

All of this is coupled with a 'learning economy' approach. Finland has a generally high standard of education. Students are exposed to ICT at an early age and computer literacy is a part of the national curriculum. Every school and college has fast Web access via ISDN. Reacting to the demand for trained professionals, universities and technical schools have dramatically expanded their computer and IT-related programs over the past few years. Finland produces five times as many science and technology graduates as law graduates.

Finns have embraced information technology to a remarkable degree (Tapper, 1999). Finland now boasts the highest per capita Internet and mobile phone use in the world.

Ireland

In one decade the Celtic Tiger has transformed itself from an ailing, virtually bankrupt economy into one of the fastest growing, dynamic economies in the developed world. Like New Zealand, Ireland has been a model of fiscal restraint, tax reform, income moderation, and labour market flexibility (Information Society Commission, 1999). But between 1990-1997 Ireland's economy grew at an annual average rate of just under 7 per cent, compared with annual growth of less than 2 per cent in the EU overall.

Ireland maximised advantages of location by...

Ireland accomplished a great deal by:

- investing heavily in education, especially technical education
- correcting major imbalances in the government finances and putting fiscal and monetary policies in order
- controlling excessive costs and keeping wage increases moderate
- opening up the economy and privatising many state-owned enterprises
- positioning Ireland as the 'hub' between Europe and the global marketplace (Ireland trades 153 per cent of its GNP)
- enacting strong legislation designed to open up previously sheltered activities to competition in the interests of consumers
- creating incentives and stimulating the economy through lower taxation.

Investing heavily in education and having a clear strategy

It has to be acknowledged that the Structural Funds provided by the European Union to disadvantaged regions have played an important (but by no means exclusive) role in accelerating Irish growth. As a result of the jump-start, Ireland now has a thriving information technology industry, with electronics and software exports now amounting to 40 per cent of total exports. Ireland's growth can be attributed to its openness to economic globalisation, the presence of foreign (predominantly US) companies due to tax advantages they enjoy, and the Irish government's efforts to foster the development of national resources and organisations (O'Riain, 1997)

Now citizens stay and emigrants return

By converting itself to a knowledge-intensive economy, Ireland finds its young minds are staying rather than emigrating. Former emigrants have returned and women's participation in the labour force has begun to rise rapidly. The large investment in upgrading education and training is now paying dividends.

Canada

Somewhat overshadowed by the US, Canada is nonetheless an interesting model for New Zealand to study. All surveys point to its having a sound infrastructure, strong content, as well as serious government investment and support. With just over 30 million people, Canada has about 7 million established Internet users. Canada presents a solid consumer base for an electronic economy (Burke, 1999).

In September 1995 the Information Highway Advisory Council (IHAC), presented its strategy detailing recommendations for an Information Super Highway strategy for Canada. More recently, its paper *Preparing Canada for a Digital World* has accelerated this strategy. Five principles have shaped IHAC's approach:

- an interconnected and interoperable network of networks

- collaborative public and private sector development
- privacy protection and network security
- competition in facilities, products and services
- lifelong learning (Industry Canada: Information Highway Advisory Council, 1997).

The Government networked schools and communities to information highway

Canada's strategy recognises the central importance of education and the need for its young people to form the core of the technologically literate, versatile work force in the knowledge economy of the future. In 1999, the government announced a budgetary investment of US$1.2 billion in IT projects, incorporating a US$134 million investment in the education system and in community access programmes. The initial objective of 'SchoolNet' was to provide 16,000 schools and 3,400 public libraries with Internet access by the end of March 1999. Canada ranks high or very high among our major trading partners in:

- spending on information and communications technology
- the competitiveness of its information and communications sector
- the degree of competition and liberalisation in its communications policy and regulatory environment
- the modernisation of its communications system
- the pricing of communications services
- the overall penetration of new technologies
- high educational attainments (Melnyk, 1997).

But low investment in R&D causing problems

Yet Canada's strategists have realised that closer examination of these key indicators shows some of its competitors are moving ahead of Canada in performance. Canada's overall expenditures on R&D – an indicator of the innovation so vital to a knowledge economy – represents a smaller portion of gross domestic product (GDP) than in many industrialised countries. Canada ranks only in the middle of the pack with respect to per capita capital investment in information and communications technology. It is estimated that about 300,000 Canadians have moved to the Silicon Valley area and another 600,000 are located in and around Los Angeles (Avery, 1999).

Singapore

Small, with no natural resources

Singapore, a tiny island (600 km^2) with no natural resources, has prospered by being useful to others, by adding value to goods, and exploited its location by providing hub services such as banking and finance, transport and logistics. If IT does nothing more than magnify the abilities and talents of people, then Singapore has amply demonstrated this principle.

Government strategy is to become an "Intelligent Island"

Singapore was one of the first countries to take the route toward a knowledge-driven economy. In 1981 Singapore launched a programme to computerise its civil service. In 1986, the National IT Plan was formulated. In 1992, IT2000 was launched, which spelled out the vision of turning Singapore into an 'Intelligent Island' (Hardy, 1998).

Singapore's decision to convert itself into a knowledge economy has borne fruit. Today, nearly half its homes have a personal computer and one person in five uses the Internet. In 1997 its IT industry was worth US$7.3 billion (sales of hardware, software and IT services to end users, excluding manufacturing output and sales to distributors). Out of every 100 Singapore homes, 98 now have access to Singapore ONE, the world's only nation-wide broadband network. The plan is to put all key government services in Singapore on-line by 2001 and 50 per cent of businesses into electronic commerce by 2003 (Tan, 1999).

IT culture promoted with 98% of homes "connected"

Programmes are available to bring people up to speed with the technology. There are formal educational initiatives in schools, as well as mass training programs for the working population. ICT culture promotion programs are designed to put IT facilities into public libraries and community centres. The aim is to reach out to people of all ages, from all sectors of the population, to ensure that no one is left out.

The latest prediction by International Data Corporation is that in the next three years Singapore will surpass Finland and become the world's second leading information economy (Chellum, 1999).

United States

Turned around decline of industrial economy

In the early 1980s, throughout industrial America, factories were closing. Massive layoffs put hundreds of thousands of people from the smokestack industries onto the dole. By the mid 1990s these dislocations had been overcome, their losses replaced. The US unemployment rate is now below 5 per cent, and in the high-tech sectors much lower than that. Information and services make up half of the new jobs.

All the right indices are up: GDP, capital spending, incomes, the stock market, employment, exports, and consumer and business confidence. Unemployment, inflation, and interest rates are down. In a literal application of Schumpeter's notion of *creative destruction*, the United States lost some 44 million jobs in the process of adjusting its economy but simultaneously created 73 million private-sector jobs, a net gain of over 29 million jobs since 1980. A stunning 55 per cent of the total work force today is in a new job, some two-thirds of them in industries that pay more than the average wage (Zuckerman, 1999).

Companies invest heavily in IT and R&D

The United States is poised to dominate the knowledge industries of the future. In fact, the twenty-first century may be another American century (Joffe, 1997; Nye and Owens, 1996; Zuckerman, 1999). How does America do it?

- US companies were the first to realise the importance of computers and information technologies and have invested massively in them, accounting for over 40 per cent of the world's investment in computing. There are five times as many computers per worker in the United States as there are in Europe and Japan. US companies invest heavily in new technologies and the necessary training. US computing capacity is growing by more than 35 per cent per year.
- US manufacturers have made the transition from the smokestack era to the information age. They have replaced mass-produced consumer goods with sophisticated products that contain a huge proportion of intellectual capital. America's exports consist primarily of value-added goods that incorporate technology and intellectual capacity and do not have to compete on price alone.
- Generally Americans in aggregate spend vastly more on research and development than their competitors and the gap between the United States and the rest of the world is growing. America dominates the Internet: 90 per cent of Web sites are American.

Culture of enterprise and innovation

The cultural element is also not to be underestimated. American culture cherishes individualism, entrepreneurism, pragmatism, and novelty. It nourishes its mavericks, prizes its young, welcomes newcomers, and dramatically opens to energy and talent rising from the bottom up. Bankruptcy is not stigmatised.

Although the Internet's antecedent, the ARPANET, was the creation of government-funded research, the Internet has now been turned over to the commercial sector by the US government. The parameters for the US policy approach were set in July 1997 when President Clinton released *A Framework for Global Electronic Commerce* (United States Interagency Working Group on Electronic Commerce, 1997).

50-60 million people on-line

The United States is the world's most advanced information society. It is the first country in which the Internet is reaching mass proportions. One-fifth of households (around 20 million) are on-line. Another 30 million Americans can access the Internet from networks at schools, universities, and workplaces. In total, there are 50-60 million Americans on-line, while about 10 per cent use the Internet regularly to purchase goods and services.

Table 1 *Key ingredients of national knowledge economy strategies*

Country strategy	Stated priorities	Comments
Australia Information economy On-line Services strategy Networking the nation	• On-line services development and use economy-wide • Electronic commerce • Government use of IT • Emphasis on industry self regulation • Deregulation of telecommunications industry	• From 1 July 1997 there has been a focus on service provider competition. One third of Telstra was privatised in 1997 to encourage inexpensive and diverse services. • Policies have been co-ordinated through the National Office for the Information Economy, which was established in 1997. • Government services such as customs and quarantine offered on-line. Government support for initiatives to boost SME awareness of e-commerce, programmes to assist IT firms to access venture capital. • Extending benefits of the on-line economy to rural and remote areas.
United States Information superhighway	• Funding next generation Internet • Services and applications development • Specific principles relate to universal service and connection of health and educational institutions	• There has been a shift from a vision of national interconnected broadband networks to a focus on the Internet as a backbone network. • Developments are largely market driven with some government funding, particularly of R&D.
Canada Information highway	• Modernise existing infrastructure • Emphasis on promoting Canadian culture, content and access • Internet as central backbone • Recognition of importance of benchmarking • Government as lead user, delivering services and on-line procurement	• Uses a primarily market driven approach, with significant government facilitation of R&D. • The information highway development is explicitly linked with introduction of competition across IT sectors. • The government aimed to provide Internet access to all schools, libraries, universities and communities with a population of over 400 by end of 1998.
European Union Information society	• Network interoperability and infrastructure development across Europe • Examination of the social implications of IT • Focus on pilot projects and promotion of collaborative, cross border research programmes • Accelerate the uptake of IT by SMEs and create international business strategies	• The introduction of competition to IT markets is core policy approach. • Promotion of cross-border R&D is critical. • Legislation protecting privacy and security will help overcome negative consumer perceptions.
United Kingdom Information society	• Reduce risk of non-tariff barriers to trade • Infrastructure competition • Strong link between IT development and economic (particularly regional) development • Fulfil training needs of industry	• The UK has a long standing model of infrastructure competition. • Cable infrastructure forms basis of nation-wide broadband network development strategy. • The government has made clear statements on the benefits of the on-line economy. • Major stimuli for government, business and community efforts to go on-line. • Delivery of Internet-based training courses for SMEs.
France L'Informatisation de la Societé	• Infrastructure development based on fibre optic rollout • Redress low cable penetration and infrastructure limitations that impede service deployment • Strengthening French language • Connection between culture and commerce	• Significant government direction of strategy. • France Telecom has key role in fibre cable roll out and conduct of broadband trials. • Includes promotion of French language multimedia content and use of IT across the arts.
Singapore Intelligent island IT 2000	• Infrastructure to enable service and application developments • Attraction of transnational value-added activities onshore • Focus on target projects and trials • Agenda includes target dates for fibre optic network developments and investment projects • Government-led legal framework on digital signatures and EDI	• A strong government role based on long-term planning and Singapore Telecom as a key player. • The introduction of competition is not central. • Service developments focus on government applications. • Singapore One broadband intranet for commercial and government services passes all households. • Government trial of smart cards/readers.

Japan Informatisation of society Info-communications infrastructure	• Infrastructure development via introduction of competition • Aims to redress economic downturn, reduce urban concentration and re-energise local IT industry • Focus on broadband rollout, government funding of R&D and trials • Promotion of SME use of the Internet	• The policy agenda has centred on restructuring Nippon Telephone and Telegraph throughout the 1990s. • In the late 1990s, the emphasis on infrastructure development has shifted to Internet and multimedia service developments. • Government projects on electronic money, virtual shopping malls and secure payment.
South Korea Informatisation	• Infrastructure development based on two networks: public and private • Strategy includes target dates for network developments and funding projections	• The agenda is influenced by strong business interests and different bureaucratic agendas. • In the late 1990s the focus has shifted to the Internet as backbone for network development. • Government-created community access and training centres.
Malaysia Information-rich society	• ICT policies part of a broader modernisation programme • Multimedia Supercorridor Infrastructure	• Has a high profile agenda with strong Prime Ministerial support, attracting significant global attention.
New Zealand	• A subset of wider economic and commercial sector policy	• Has a competitive deregulated telecommunications environment. • Promotion of competition and market-led. development are central to government policy. • Has IT Minister and a private sector Advisory Group and recently established government e-commerce steering committee. • R&D is largely provided by the public sector and focussed on primary production sector. • Well established privacy protection. • Public consultation through the 'Five Steps' programme.

Sources: CIRCIT at RMIT and Program on Information and Resources Policy, 1998 cited in (Northfield 1999); and Commonwealth of Australia, Department of Foreign Affairs and Trade

Lessons for New Zealand

All the national knowledge economy strategies we examined have similar attributes:

- an efficient and cheap universal telecommunications network
- improved productivity through information-intensive, value-added businesses
- improved industrial and commercial competitiveness
- support for the information services sector
- a focused investment in education and training (especially technical education) together with lifelong learning and up-skilling
- a better-informed populace with higher level of participation in democracy
- support for cultural values.

How does New Zealand compare?

Economic fundamentals right

In many ways, New Zealand is doing quite well. The reforms of the last 15 years have ensured that we have many of the economic fundamentals right. In some respects countries such as Ireland, Finland, and Australia are still working towards that position. But in other ways we have a long way still to go.

We're strong in infrastructure and use of technology

We can see our strengths and weaknesses when we compare ourselves against the top 15 countries rated in the Information Society Index (Gifford, 1999), using important cross-national indices (see Table 2). In many of the measures New Zealand rates well. In terms of ownership of personal computers, enrolments in tertiary education, and the cost of international telephone calls, we rate quite satisfactorily against our competitors. We distinguish ourselves particularly in terms of the number of Internet hosts per capita and in public expenditure on education.

Weak in hi-tech exports and technical graduates

But we are at the bottom of the ranking in two key indicators for the knowledge economy: the percentage of exports that are high technology, and the number of technical graduates (computer science, maths and engineering) per 1000 population. In addition, we have the lowest number of scientists and engineers in R&D per 1M population: and are second lowest in the number of science graduates per 100,000 population in the labour force.

How does New Zealand compare with other countries in terms of the development of its knowledge economy? Figures 1 & 2 reveal the shape of the knowledge economy on an imaginary

Table 2 *How New Zealand stacks up*

Indicators/ countries (ranked by 1998 Information Society index)	TV sets	Newspaper readership	Telephone lines	International phone costs	Mobile telephone index costs	Internet hosts	Personal computers	Hi-tech exports	High-tech % manufacturing	Public expenditures on education	Tertiary enrolment	Science graduates in the labour force	R&D personnel nation-wide	Scientists and engineers in R&D	Technical graduates
1. United States	806	212	640	2.78	165	442	362	44	37	5.3	81	688	963	3,732	85
2. Sweden	476	446	682	0.72	282	321	215	31	22	8	43	458	63	3,714	115
3. Finland	605	455	549	0.45	292	654	182	23	16	7.6	67	792	34	3,675	160
4. Singapore	361	324	513	0.53	141	196	217	71	N/A	3	34	N/A	11	2,512	N/A
5. Norway	569	593	555	0.85	287	475	273	24	11	8.3	55	855	24	3,434	89
6. Denmark	533	311	618	0.57	250	260	304	25	18	8.3	45	683	30	2,647	78
7. Netherlands	495	305	543	0.82	52	219	232	42	23	5.3	49	691	79	2,656	82
8. Australia	666	297	519	0.36	208	382	311	39	10	5.6	72	922	86	2,477	66
9. Japan	700	580	489	0.29	214	76	128	39	37	3.8	40	974	948	5,677	100
10. Canada	709	159	602	0.93	114	228	193	24	13	7.3	103	668	129	2,322	100
11. Switzerland	493	330	640	0.52	93	208	409	N/A	N/A	5.5	32	302	48	N/A	31
12. Hong Kong	388	800	547	0.38	216	75	151	27	N/A	2.8	N/A	N/A	N/A	N/A	100
13. New Zealand	517	223	499	0.46	138	424	266	11	5	7.3	58	453	11	1,778	19
14. United Kingdom	612	332	528	1.00	122	149	193	40	33	5.5	48	989	279	2,417	136
15. Germany	493	311	538	0.84	71	107	233	25	21	4.7	43	650	470	3,016	72

Indicators	*Units of measurement*	*Date*	*Source*
TV sets	*No. per 1000 pop*	*1996*	*1*
Newspaper readership	*Circ per 1000 pop*	*1996*	*2*
Telephone lines	*No. per 1000 pop*	*1996*	*1*
International phone costs	*1/US$ per 3 min**	*1996*	*1*
Moblile telephones	*No. per 1000 pop*	*1996*	*1*
Internet hosts	*No. per 10,000 pop*	*Jul 97*	*1*
Personal computers	*No. per 1000 pop*	*1996*	*1*
High-tech exports	*% of total exports*	*1996*	*1*
High-tech as % of manufacturing	*% of manufacturing*	*1993*	*3*
Public expenditure (Education)	*% of GNP*	*1995*	*1*
Tertiary enrolments	*% of pop over 15 yrs*	*1995*	*1*
Science graduates in the labour force	*No. per 100,000 pop aged 25-34 yrs*	*1992*	*4*
R&D personnel nation-wide	*No. per 1M pop*	*1996*	*5*
Scientists & engineers in R&D	*No. per 1M pop*	*1981-95*	*1*
Technical graduates	*No. per 1000 pop*	*1992*	*4*

* *Inverse of cost per minute at peak rates for calls to US (except for the US where the cost is based on calls to Europe)*

1. *World Development Index (World Bank 1999)*
2. *UNESCO (1999)*
3. *OECD (1996b)*
4. *OECD (1995)*
5. *The World Competitiveness Yearbook (1998),*

radar screen, based on 13 indicators measuring infrastructure, experience, skills, and knowledge. The circle represents an arbitrary baseline against which data from the various countries have been normalised. Viewing the shape of different knowledge economies on the radar screen makes it easy to compare New Zealand's development on key indicators against some of our competitors. The figures are based on the INEXSK methodology developed by Mansell and Wehn (1998). The 13 selected indicators are listed in Table 3. The 'Ideal' indicator is a combined index of knowledge society development (International Data Corporation Information Society Index).

As Figure 1 shows, New Zealand has a similar shape of development to countries such as the US, Finland and Australia, although it lacks an articulated strategy for creating a knowledge economy. As the radar screen shows, we are best described as being a 'junior' version of the US, heading in the right direction, but lagging behind in critical areas.

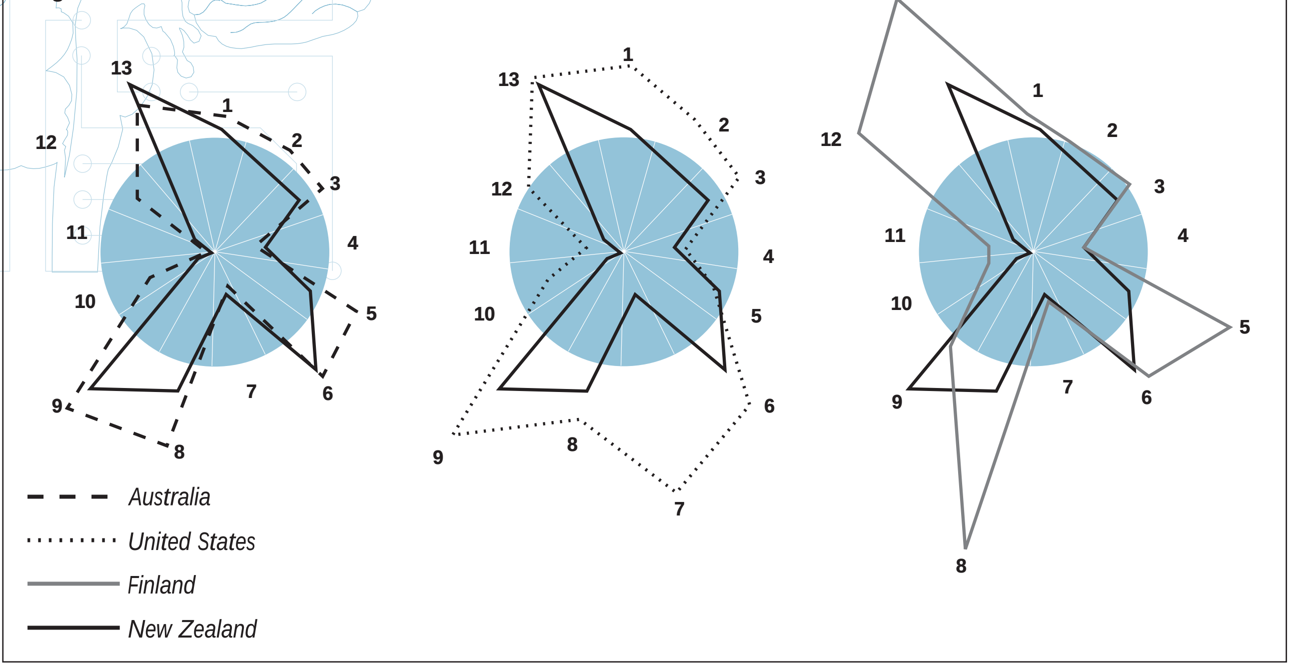
Note that the United States exports more high-technology goods and has a higher proportion of technical graduates, whereas Finland produces far more technical graduates and has more Internet hosts. Australia has more tertiary enrolments and produces more technical graduates. To compete with the mature pattern exemplified by the United States (closely followed by Finland and Australia), New Zealand must increase its number of technical graduates, electronics production, and high-technology exports.

We face competition from a range of countries

Countries such as Singapore, Malaysia, and South Korea, shown in Figure 2, are serious competitors, as they excel in electronics production, with South Korea also having a high proportion of technical graduates. However, they lag behind New Zealand in having fewer Internet hosts and a lower rate of PC ownership.

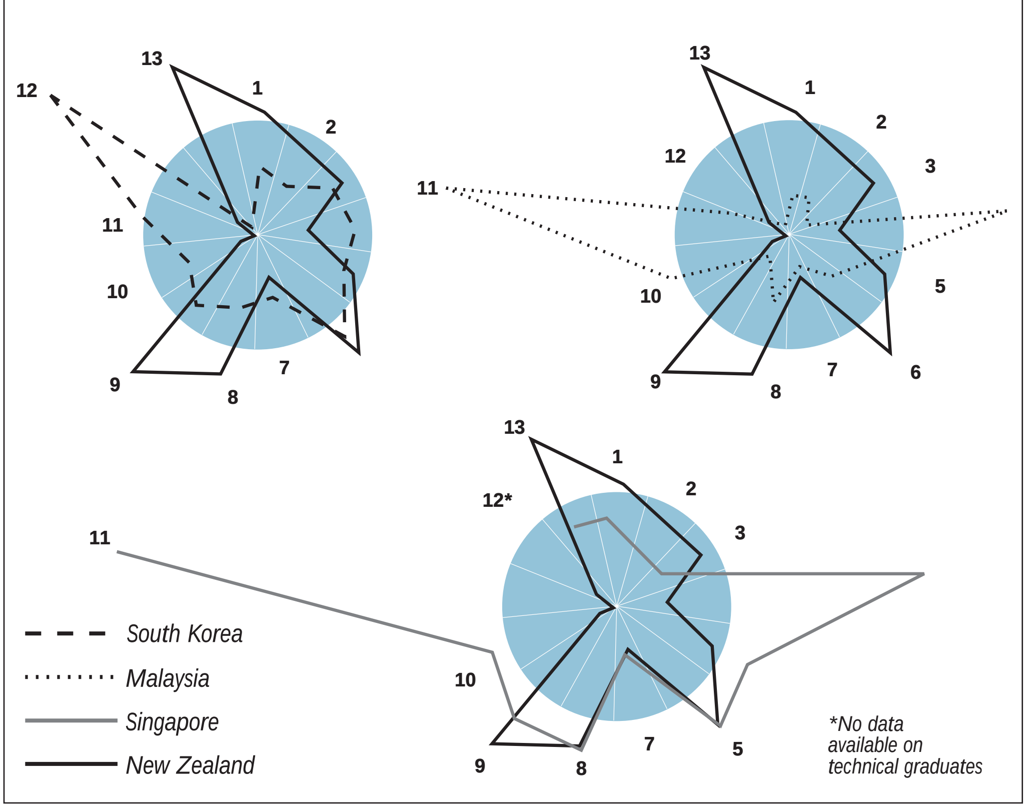
Countries such as Hungary and Brazil are often mentioned as potential competitors to New

Figure 1



We're a junior version of the US but lagging behind in two critical areas, technical graduates and hi-tech exports

Figure 2



Zealand, yet the data show that they are currently behind us, while Mexico leads us in high-technology exports, electronics production, and technical graduates (Mansell and Wehn 1998).

We've got the nucleus of a knowledge economy

Nonetheless, New Zealand's private sector has brought into existence the nucleus of a knowledge economy that has tremendous potential. New Zealand's technology sector already provides a significant contribution to gross domestic product. At NZ$10.4 billion, New Zealand is the world's leader in per capita expenditure on information and communications technology, and has achieved this distinction for five of the past six years (World Information Technology and Services Alliance and International Data Corporation, 1998).

Supported by high Internet use

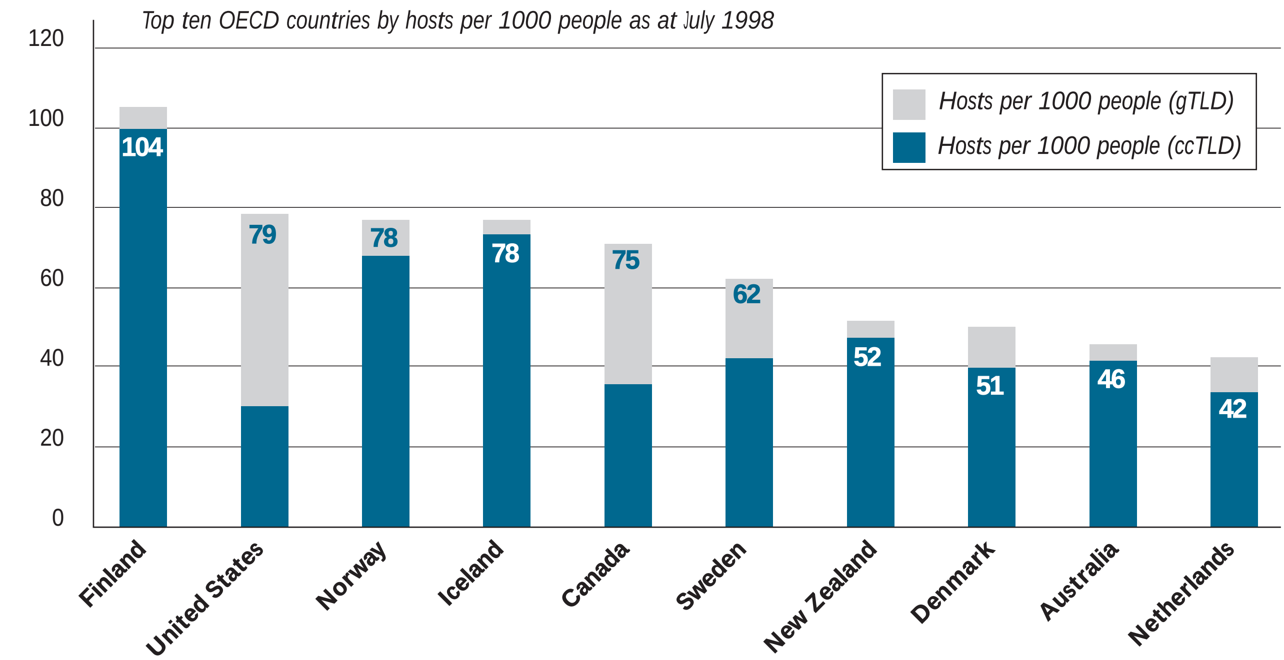
The number of New Zealand homes with computers is growing at 14 per cent per annum, and reached about 40 per cent in 1999 (March, 1999). The number of Internet users in New Zealand also continues to grow rapidly. The number of users in the education sector will continue to predominate but their share of the total New Zealand Internet-user population is projected to drop from about 35 per cent in 1999 to about 28 per cent in 2002. There will be a corresponding increase in the proportion of home users, rising from 24 per cent to 28 per cent by 2002, and in small business users, rising from 11 per cent to 13 per cent in 2002. By 2002, 55 per cent of the users will log in from multiple locations (International Data Corporation, 1998).

One measure, Internet hosts per capita, identifies New Zealand as among the world's most networked countries, as shown in Figure 3 below (March, 1999a).

Table 3 *Indicators of knowledge economy development*

	Indicator	Type
1.	'Ideal' indicator	
2.	Televisions	Consumption skills
3.	Tertiary enrolments	
4.	Electronics consumption	Consumption
5.	Newspapers	
6.	Telephones	Infrastructure
7.	International call costs	
8.	Mobile phones	
9.	Personal computers	
10.	High-tech experts	Production
11.	Electronic production	
12.	Technical graduates	Production skills
13.	Internet hosts	

Figure 3 *Connections to the Internet*



Used as a testing ground for new technologies

New Zealand is being used as a testing ground for innovations in technology. Here are some examples:

- Ericsson New Zealand (http://www.ericsson.co.nz) is trialling its 'deskless office' concept and its Third Generation Internet technologies in New Zealand.
- BankDirect (http://www.bankdirect.co.nz) is testing the security and user friendliness of its on-line banking system in New Zealand before introducing it elsewhere.
- IBM's Integrated Customer Management System (http://www.ibm.co.nz) was developed in New Zealand and is now in use in 30 countries.
- International Data Corporation (http://www.idcresearch.co.nz) predicts that New Zealand will have one of the highest growth rates in electronic commerce. By 2002 a third of all New Zealanders will be buying on-line (International Data Corporation, 1998).

The world doesn't know it, but New Zealand already produces the successor to C++ (the world's most popular programming language) under the name JADE. Gil Simpson of JADE says: "I constantly confront people who tremble and shake and go red in the face at the audacity of this little company in Christchurch daring to even think we could create something that Microsoft hasn't created" (Brett, 1999).

Exciting developments in software

No one should underestimate the Kiwi software industry.

- JADE is about to make the leap to global sales, particularly for its electronic commerce products (http://www.jade.co.nz). ASB Bank used JADE to develop its on-line banking service – the first Internet banking service to go live in the Southern Hemisphere (http://www.asbbank.co.nz).

- Fisher & Paykel have developed a new software field – dishwasher computing – in which householders literally put their dirty dishes into a computer (http://www.fp.co.nz).
- Norton Ghost PC-Cloning software was developed in New Zealand (http://www.ghost.co.nz).
- Terranova Pacific won a contract with London hospitals to deliver patient software (http://www.terranova.co.nz).
- Two Kiwi companies, Luc Encryption Technologies Ltd and RPK, have won world-wide market share with their encryption software (http://www.luc.co.nz), (http://www.rpk.co.nz).

And in media content industries

New Zealand is renowned for its new media content industries. The Hollywood film industry has long known about New Zealand, not only because of its famous actors and film productions but also because of its renowned advanced imaging industries.

- Weta Digital Effects is shooting Tolkien's *Lord of the Rings* for New Line Cinema (http:// www.wetafx.co.nz).
- Animation Research Labs delivers 3-D aerial-view golf graphics to ESPN and the US PGA (http://www.arl.co.nz).
- Terabyte Interactive is marketing its 'Virtual Spectator' to American Express so that its customers can experience the America's Cup live on the Internet with 3-D graphics (http://www.terabyte.co.nz).
- Galaxy Kids (http://www.galaxykids.co.nz) delivers a total learning environment and a library for children between 3 and 7 years old in all English language variations.

New Zealand is definitely on the map as a culture producer. New Zealand can easily profile itself as a creative powerhouse, from its Oscar nominees and winners to its world-renowned Web designers and award winning advertisements. New Zealand can draw on tremendous resources in this sector: leading-edge developments at the new Museum of New Zealand Te Papa Tongarewa (http://www.tepapa.govt.nz), award-winning film and television productions for international markets, inspiring educational products for multicultural global markets, museums, conferences, international summits, historical sites, product launches, tourist attractions, theme parks and leisure centres.

Galaxy Kids and Sunshine On-line

The single most important factor in stimulating the creation of a knowledge economy is education. Already one New Zealand company is pioneering Internet education: educational publisher Wendy Pye, with Galaxy Kids. On 25 September 1998 Wendy launched the Web site http://www.galaxykids.co.nz. The site is intended for children aged from 3 to 7 years. The parents of the participants pay $144 ($120 if paid in one sum) per year and the child logs on to the site where they enrol for a course designed to improve their reading, maths and language skills. Galaxy Kids aims to provide three and a half hours of formal instruction per week. The course can be downloaded on to the home computer so the child can take the lessons when they choose. A parallel programme, Sunshine Online, is offered to 5 to 12 year olds through http://www.sunshine.co.nz. The company is now in firm negotiations for a Korean/English language site and a Spanish/English language site, as well as a Chinese one in Mandarin.

Early on, Wendy realised that children's educational programmes must be produced by local people to be appropriate for local audiences. The software for the site has been developed by, or for, Wendy Pye, who has signed contracts with overseas parties in Australia and the United Kingdom. They in turn intend to develop their own Galaxy Kids sites in those countries. It's the local flavour that has made Galaxy Kids so successful in New Zealand, compared with overseas programmes. So Wendy's company, Sunshine Multimedia Limited, transmits the core issue down the satellite to the portal in the UK or Australia which re-transmits it to the parents and children in that country. Wendy's company, which develops and publishes book and Internet products, now has 40 staff.

Six key issues for New Zealand to address

What are the critical success factors for fostering the growth of the knowledge economy? We list some key issues that New Zealand must address if we are not to be left behind.

Education

Learning impacts on earnings

Thirty years ago, Singapore, Hong Kong, Taiwan and South Korea were all low-income economies. How have they managed to bridge the income gap that once separated them from New Zealand and the rest of the OECD? What has made the difference? Economists now believe it wasn't that these countries were working harder, they were working smarter. All four invested heavily in education and training. These were the countries where parents encouraged their children into science and technology. These are the countries giving living proof that high educational achievement leads to economic growth. But education is not enough in itself:

> Education without openness to innovation and knowledge will not lead to economic development.
> (World Bank, 1999)

Given our aging population, life long learning is a must

Education is vital not only for children and young people. Because of New Zealand's aging population (the baby boom phenomenon), 80 per cent of people who will be in the workforce over the next 10 years are in the workforce already. In the next decade the numbers of young people aged 15-24 in the labour force is projected to increase by only approximately 40,000 (Statistics New Zealand, 1998a). The proportion of young people in the population is projected to decline until at least the middle of next century – a trend that has been apparent since 1976 (Statistics New Zealand, 1997b). It is critical that middle-aged and older people in the workforce also have access to education and training.

One of the ways to ensure access to leading-edge knowledge is to train, retain, and attract the best people. The most significant lessons of the new economics in relation to education are:

– It is a lack of investment in human capital, not a lack of investment in physical capital, that prevents poor countries from catching up with rich ones. Educational attainment and public spending on education are correlated positively to economic growth (Barro and Sala-i-Martin, 1995; Benhabib and Spiegel, 1994).
– School quality measured, for example, by teacher pay, student-teacher ratio, and teacher education is positively correlated to future earnings of the students (Card and Krueger, 1992).
– Education is important in explaining the growth of national income. Life-long learning is also crucial (Aghion et al., 1998).
– People with human capital migrate from places where it is scarce to places where it is abundant (Lucas, 1988). 'Human capital flight' or 'brain drain' can lead to a permanent reduction in income and growth of the country of emigration relative to the country of immigration.

We need more technical graduates

In New Zealand, the proportion of technical graduates, especially at masters and doctorate level, seems to be low in proportion to the importance of the technology to the economy and society in general, as Table 4 shows.

In the field of information technology, this situation came to a head when the American software giant Motorola first considered whether to open a factory in New Zealand employing 400 highly skilled people to produce chip design, smart technology, and other software products. Desiring to hire 100 graduates a year, Motorola stated its intention to interview at least 1,000. But New Zealand produces a total of 1005 graduates per year in all relevant disciplines (NZ Vice Chancellors Committee, 1998). In other words, *one corporation needed to interview the entire country's one-year's graduate output for its own needs.* In their current deliberations, Motorola is placing emphasis not only on being able to hire sufficient graduates with requisite skills, but on there being an education system which can assist with their on-going development, as initial skills become obsolete.

The total number of graduates for 1997 was 21,493 (New Zealand Vice Chancellors Committee nd). New Zealand graduates in IT related disciplines were only 4.7 per cent of all graduates in 1997.

Table 4 *New Zealand graduates in IT-related disciplines in 1997*

Field of specialisation	Annual graduates
Computer science	390
Information technology	33
Information systems	366
Electrical/electronic engineering	180
Information engineering	21
Electronics	15
Total	**1005**

Source: Vice Chancellors Committee

Such figures, however, only tell part of the story. Other academic studies such as mathematics provide students with significant computer skills. It is clear that many commerce students have substantial information systems/technology papers in their degrees. Often the "practical" IT skills taught by polytechnics are more sought after by industry than pure academic qualifications. To advance progress towards a knowledge economy, reliable information is needed on the number of tertiary education places in relevant disciplines and the relationship between labour market supply and demand. This way government investment in education can be directed to best effect, and investors and employers gain a more accurate idea of the potential labour force available for their areas of need.

Practical as well as academic skills

In October 1998 the Government published *Interactive Education: An Information and Communication Technologies (ICT) Strategy for Schools* (Ministry of Education 1998). By the year 2002, this strategy envisages that schools in New Zealand will be:

– improving learning outcomes for students by using ICT to support the aims and objectives of the New Zealand curriculum and by providing ICT professional development for teachers and principals
– using ICT to improve the efficiency and effectiveness of educational administration
– developing partnerships with their communities to enhance access to learning through ICT.

Increase ICT literacy for students and teachers

In 1998 school principals in New Zealand reported that 58 per cent of primary staff and 33 per cent of secondary staff attended some ICT training. Probing more deeply, the statistics reveal that the education sector is lagging behind others in its use of computers and the Internet. In 72 per cent of our secondary schools, less than a quarter of the teaching staff have access to the Internet, while 56 per cent of school principals use email once a week or less (Information Technology Advisory Group, 1998). The figures for 1998 show that there was one computer for every 14 students in primary schools and one per eight students in secondary schools. While 83 per cent of primary schools and 94 per cent of secondary schools have some kind of Internet connection, the majority of school connections are a single user account on a stand-alone computer, connected by modem to a dial-up telephone connection (March, 1999). About a quarter of these machines are 'mixed breeds' such as Acorns, BBC Micros, or 286 PCs.

These statistics show that there is a low penetration of computers and networking connectivity in schools in New Zealand. The problem starts in the teachers colleges, where until recently large numbers of graduates have never worked with a keyboard. There is no requirement for teachers to be ICT-competent in order to be registered. Teachers lack access to telecommunications networks, and consequently lack ICT knowledge. It is imperative that teachers are able to access courses which enable them to come up to speed with ICT and are provided with technical resources and support for on-going development: to keep them up to date.

ICT courses needed at school to encourage university study

Information and communication technologies does not qualify as a subject for Bursary at Year 13 (Seventh Form), which may have an effect on subject choice at first-year university level. There are many occupations that require computer knowledge, and a range of tertiary subjects that involve ICT. Therefore care needs to be taken in defining the scope of such a course to avoid making it too narrow or rigid.

Māori success in the knowledge economy

Māori success in the knowledge economy is central to honouring the principles of the Treaty of Waitangi, particularly in respect of intellectual property rights, and full participation in society. This success will enable Māori to improve their well being, and provides a more solid foundation for national well being.

National well being and the well being of Māori are inseparable. The more youthful and fertile nature of the Māori population, and the older and less fertile nature of the Pakeha population, means that Māori will be an increasing proportion of young and working age New Zealanders in the twenty-first century. Māori culture is unique to New Zealand. Māori participation in the knowledge economy provides an opportunity for New Zealand not only to promote Māori enterprises in the global economy but also to explore how this uniqueness can be used to distinguish New Zealand from other "western" societies and economies.

National well being and Māori well being are inseparable

Māori relationship with knowledge

The relationship between Māori and knowledge is different to that between Pakeha and knowledge. For Māori, it is the group (iwi or hapū) which owns important aspects of knowledge. In the Pakeha tradition the individual or firm owns knowledge. Māori place great importance on the concept of cultural property. These are the rights of cultural and ethnic groups to control of the knowledge and information created over generations by the group, and which should not be vested in an individual, and which in many instances are ineligible for protection under conventional intellectual property mechanisms.

For Māori it is the "group" who owns important aspects of knowledge

These differences may present challenges to Māori as they become increasingly involved in the knowledge economy, and to Pakeha who seek to unilaterally use Māori knowledge. Māori desire to protect their knowledge, particularly when it is used for the commercial profit of other parties, (such as the healing properties of certain plants) and when their cultural knowledge (including images) is reproduced. These are not new issues for Māori communities. However, today's ease of reproduction and dissemination, in particular through the Internet, and the increased value of knowledge and *content*, have highlighted the problems faced by Māori in seeking to protect their property.

In many ways there is a tension between the objectives of an intellectual property rights regime and the aspirations of Māori in this respect. Equally there are pressures to keep intellectual property laws 'separate' and, if protection is to be given to cultural property, to enact sui generis (stand alone) legislation (AJ Park & Son, 1997). As the Government is currently examining ways in which the existing regime could be adapted to meet some of the concerns of Māori, it is hoped that progress will be made in advancing appropriate use of Māori knowledge for both Māori and general economic well being.

Unique branding for Māori and for New Zealand

The more that Māori engage in discussions and debate around the knowledge economy, the more likely it is that some of the tensions between differences in the treatment of knowledge will be resolved. This is particularly important because, in addition to the commercial potential of particular aspects of Māori knowledge, Māori culture as a whole brands New Zealand as a distinctive South Pacific nation with a unique indigenous tradition. In global economies, and in Internet commerce, nation-based brand distinctiveness is a significant asset.

Māori culture is very important for New Zealand branding

Māori music, art and drama are already used to brand non-Māori New Zealand enterprises – the All Blacks' use of haka, and Air New Zealand's use of the koru, Māori waiata and people. However, Māori have deep concerns over cultural misappropriation, and are of the view that any branding of New Zealand through Māori imagery must take place only with the active agreement of Māori.

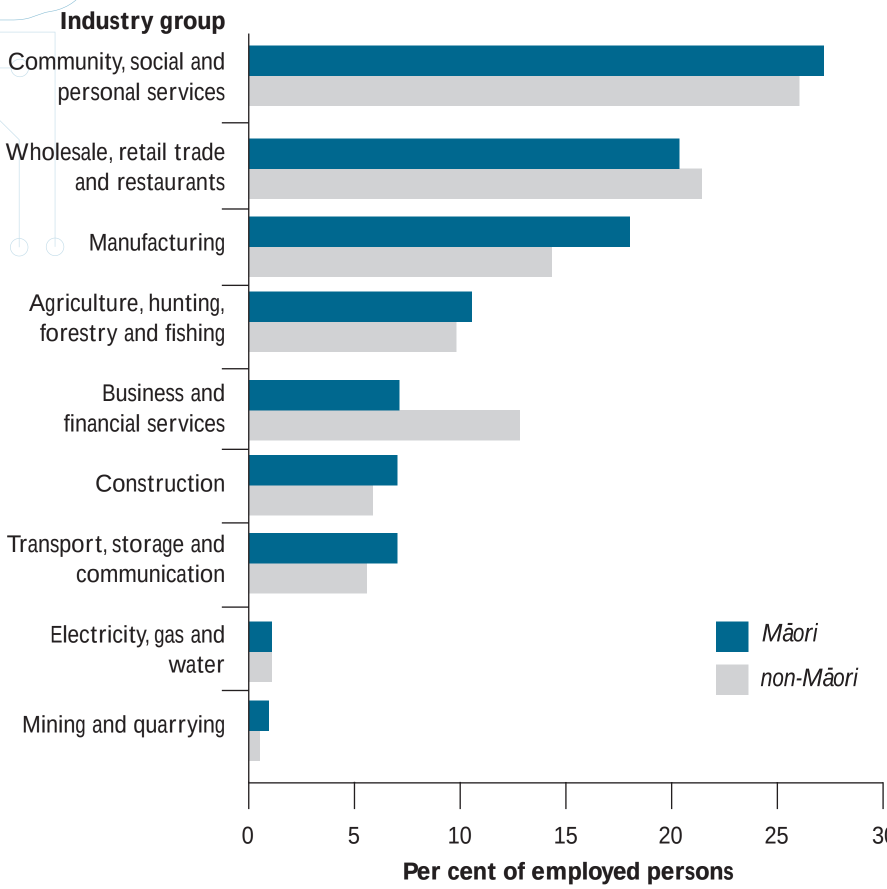
Branding through Māori imagery can take place only with Māori agreement

Current employment situation a recent phenomenon

Traditionally Māori employment was concentrated in commodity-based (primarily agriculture) and manufacturing industries. The restructuring of these industries has led to the situation of the last decade where Māori unemployment has been over three times that of non-Māori unemployment. Māori are now concentrated in the community service and wholesale/retail sectors, as Figure 4 (overleaf) highlights.

As a result, between 1986 and 1996 the inflation-adjusted median income of Māori men fell more than the rate for non-Māori, from \$16,300 to \$12,900; from 88.7 per cent of the median income of non-Māori, to 79.3 per cent. (Statistics New Zealand 1997c). This explains in part why Māori families spend less money than Pakeha families on information-gathering activities, such as publications, computers and the Internet. Less too is spent on private education and the rate of participation in tertiary education is lower. (Te Puni Kōkiri, 1998b). Hence increas-

Figure 4 *Māori and non-Māori representation by industry*



Source: Household labour force survey 1997

The knowledge economy offers opportunities to redress Māori disadvantage

ing Māori participation in the knowledge economy is critical to reducing their economic and social disadvantage.

The importance of upskilling Māori to participate in a knowledge economy is already recognised by iwi use of Treaty of Waitangi settlement funds to provide tertiary education for their people.

Māori have a history of early technology adoption

In this context it is important to remember that in the initial decades of European settlement Māori readily adopted diverse forms of European technology, ranging from guns to books. Māori responded actively to trading opportunities, firstly within New Zealand, and then to New South Wales. (Sinclair, 1959; Dell, 1987; Walker, 1986). In addition, the decline in Māori labour market participation has been a relatively recent phenomenon as until the late 1980s, Māori had a higher rate of labour force participation than non-Maori (Te Puni Kōkiri 1999). Hence the issue now is clearly one of lack of access to relevant skill development and employment opportunities.

Needs to change for nation's well being

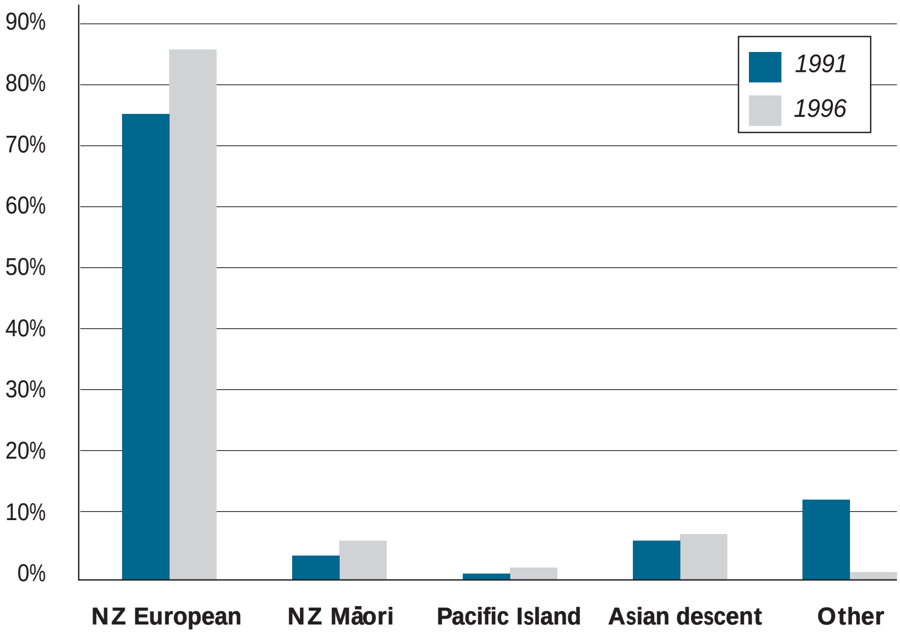
Māori and Pakeha population patterns make redressing the above problems absolutely imperative. The median age of the New Zealand population is 33.0 years, but for Māori it is a youthful 21.6 years. Between 1991-2011 the proportion of people in the labour force aged between 45-65 will increase by 73 per cent. (Statistics New Zealand 1995). Children under 15 constitute 37 per cent of the Māori population but only 23 per cent of the total New Zealand population (Statistics New Zealand, 1997c).

Māori participation vital for capability of New Zealand's future knowledge economy workforce

Given this, if continued disparities in educational achievement and rates of employment between Māori and non-Māori continue, they will have a marked effect on the level of capability in New Zealand's future knowledge economy workforce. Currently, in terms of key indicators such as income, educational achievement, labour market attachment, and consumption, Māori appear less likely to be able to participate in an emerging knowledge economy. At present only 6 per cent of people working in the IT field are Māori, only 1 per cent of Māori work in that field

Figure 5 *Māori participation in IT occupations*

Breakdown of those employed in IT occupations (excluding data entry) by ethnic origin in 1991 and 1996



(March 1996), and only around 6 per cent of New Zealand's Internet users are Māori (AGB McNair). While more and more Māori information is appearing on the Web, indications are that it is accessed mainly by non-Māori middle-class academics and researchers.

It is clear that our future national well being is dependent on the rapid upskilling and empowering of Māori so that they can participate fully in building the knowledge economy. This is underlined by the fact that Māori culture and knowledge is important to the success of New Zealand as a distinctive brand in a crowded global market place.

Immigration and the 'brain drain'

There must be no impediments to attracting knowledge workers

Immigration provides New Zealand with an opportunity to attract high calibre people with the skills and qualifications to contribute to the development of a knowledge economy. Given this, it is important that immigration policy does not present impediments to attracting the skilled people we require, or to being a desirable destination within the global labour market for skilled people. While immigration policies have attempted to address the country's economic and labour market needs, there is some evidence that they are not working as well as they might. Recent political debates on immigration policy have created more heat than light, and may have had the effect of turning away potential immigrants. There is anecdotal evidence that the points system may be too coarse-grained to attract the right kind of people to New Zealand and too slow to respond to changing market conditions.

New Zealand experienced a rapid growth in the number of immigrants from Asian countries in the early 1990s. But since 1996 immigration has declined sharply from countries that have been supplying New Zealand with knowledge workers, such as Hong Kong, Taiwan, and South Korea.

Recently, changes have been made to New Zealand's residency requirements that will recognise the experience of IT specialists and put less emphasis on their formal qualifications (Wells, 1999). This is certainly progress in the right direction but it is not sufficient to attract all the highly skilled immigrants that New Zealand needs.

Need to market New Zealand's desirable features

Because New Zealand pays knowledge economy workers relatively poorly compared to most knowledge-driven economies, knowledge workers from other countries intending to migrate or work here must trade off high earnings against other factors. There are many reasons why New Zealand might be attractive to knowledge workers:

– No capital gains tax. In the US, an American citizen can expect to pay 28 per cent federal tax and up to 5-10 per cent state capital gains tax when a business is sold.

– No estate duty.
– Telecommunications technology. As the test bed for many new technologies, New Zealand has an advanced telecommunications network that permits New Zealanders to do business anywhere in the world with high-speed links.
– "Most beautiful country in the world". People living in New Zealand are able to enjoy a lifestyle that is the prerogative of only the very rich in other countries. In an environment where a person can live and work anywhere connected to a telecommunications network, New Zealand represents an excellent environment to enjoy life while at work.

Developing knowledge industries is a way of retaining, and attracting back, bright New Zealanders

The loss of highly educated and highly skilled New Zealanders to jobs overseas is the other side of the migration problem. Well-educated people in New Zealand are twice as likely to emigrate as their counterparts in the United States and nearly twice as likely as those in Chile, according to the 1999 World Competitiveness Report. New Zealand's ability to retain skilled workers is similar to that of China and Venezuela, while countries such as the Czech Republic and Thailand are better able to retain their knowledge workers than we are (*The Economist*, 1999c).

In the year ended June 1999, permanent and long-term departures exceeded arrivals by 11,370. This contrasts with previous years' net gains of 16,770 and 450, for 1997 and 1998 respectively. While New Zealand only experienced a net migration loss in March 1997, the trend has been downwards since November 1995: a combination of reductions in immigrants, immigrants not settling as planned, and more New Zealanders travelling overseas long term and fewer returning. Permanent and long-term arrivals are down by 8.0 per cent in the year to June 1999. Permanent and long-term departures have increased 11.0 per cent in the same period (Statistics New Zealand, 1999b). It is likely that both the reduction in immigrants and the increase in emigrants are because of the attractions of employment opportunities in other countries that New Zealand cannot match. A consequence of these migration trends is a reduction in the number of people with the skills and knowledge to develop the knowledge economy.

There is an urgent need to rectify the imbalance caused by the loss of those educated New Zealanders, and to find ways of retaining and attracting back our graduates. India and Ireland are working actively to attract their high-tech expatriates back from Berkeley and London. Consideration should be given to an emigrant repatriation programme that would encourage highly skilled New Zealanders to return home. Rectifying this is the more urgent because of our aging population and our declining birth rate: now 10 per cent below replacement level.

Make New Zealand a desirable destination in the global labour market

New sources of economic growth and a strong base are necessary if New Zealand is to be competitive in a global economy. New Zealand needs to retain highly skilled people. We also need to attract people who are educated and who are willing to be resident here, people who will start businesses which employ others and to whom skills can be passed on to. Our immigration policy should ensure that it does not contain any impediments to attracting the skilled people we require to enhance development of the knowledge economy, regardless of whether or not they want to settle here permanently. To attract more skilled workers, Government needs to worry less about residency status, the nature of which can be decided later, and together with business, identify how to make New Zealand a key destination in the global labour market.

Research and development

Ability to innovate a key competitive advantage

One of the most important determining factors in the knowledge-intensive economy is the speed of science and technology innovation. The world places a high value on the ability to innovate quickly. News of innovation and research is communicated around the globe in a split second. But how do we measure the production of new ideas? One approach is to look at a country's expenditure on research and development (R&D).

R&D affects the rate of innovation and provides a multiplier effect for an economy

Recent research reports show that the economic benefits from basic research are both real and substantial (Salter and Martin, 1999). Domestic R&D affects the rate of innovation and the quantity of knowledge that can be absorbed from others (Cameron, 1996). R&D funding explains why the United States leads Britain and Germany in manufacturing productivity (UK Department of Trade and Industry, 1998). Publicly-funded R&D can be viewed as an investment in a society's learning capabilities. From Finland to America and from Australia to Canada, every dollar invested in research has a multiplier effect on the macro-economy.

> No nation can 'free-ride' on the world scientific system. In order to participate in the system, a nation ... needs the capability to understand the knowledge produced by others and that understanding can only be developed through performing research
> (*Salter and Martin, 1999*).

Table 5 *Total expenditure on R&D (as a percentage of GDP), 1997*

Country	% of GDP spent on R&D
Sweden	3.594
Japan	2.829
Korea	2.791
Finland	2.711
United States	2.546
France	2.259
United Kingdom	1.900
Slovenia	1.695
Australia	1.672
Canada	1.555
Ireland	1.523
Singapore	1.489
New Zealand	0.981
South Africa	0.746
Hungary	0.723
Brazil	0.568
Greece	0.476
Argentina	0.368
Mexico	0.309
Malaysia	0.199
Thailand	0.180
Indonesia	0.092
Venezuela	0.006

Source: The World Competitiveness Yearbook, 1999

In New Zealand, the Public Good Science Fund represents an investment in research, science and technology of about $300 million per annum. Some $20 million of public investment flowed through Technology New Zealand into the advanced technology arena, but of the nation's total R&D, only 1.3 per cent went into information technology (Braddell, 1999). According to the latest R&D survey, only 0.61 percent of our GDP goes into government funded R&D. This is less than the average for the OECD (0.76 percent) but private sector investment is also very low. In 1995/6, New Zealand's total government expenditure on research was NZ$451 million, and private sector investment in research that year totalled NZ$250 million. However, when the IT sector alone is considered, the ratio of public to private investment in research was 1:3. Government expenditure on IT research in 1995/6 was NZ$4.6 million, while private-sector investment in IT research amounted to $15 million (MORST, 1997). In terms of total expenditure on R&D (both public and private), New Zealand is more than halfway down the OECD league table, with only 0.981 per cent of GDP going into R&D, as Table 5 reveals.

A point to note is that not all our private sector R&D expenditure may be captured in such figures, partly because of the lack of tax incentives, and partly because small businesses (which dominate our economy) may record their R&D as other expenditure, or do it more informally.

Government invests a lot in R&D ... but not in key areas. Private sector investment lagging behind

Recent US research shows that government R&D funding of the IT sector led to the most explosive economic growth the world has ever known (PITAC, 1999). It has given rise to dozens of billion-dollar industries (including the Internet itself). Businesses that got their original funding from US government R&D now produce computers, semi-conductors, software, and communications equipment that account for a third of the total growth in US economic production since 1992, creating millions of high-paying new jobs. Government-funded university research has trained most of America's leading IT researchers.

Government funded R&D drove America's economic growth

> In the long run, [tax cuts] penalise efficient firms that can manage without them. That said, short-term tax-breaks can help kick-start an economic recovery or change in government policy
> (*The Economist*, 1999b).

Many overseas jurisdictions allow expensing of R&D expenditure and some provide tax incentives allowing for additional offsets for R&D against income, including accelerated capital write-offs and other special allowances. The OECD (1997) found that Australia and Canada offered the most generous fiscal incentives for R&D, whereas New Zealand offered the least favourable R&D tax treatment. Table 6 shows that, after calculating post-tax and compliance costs, for every dollar that a private firm invested in R&D, the net cost in Canada was $0.71 for large firms and $0.50 for small firms. For Australia, it was $0.89 for both categories. By contrast, the comparable figure given for New Zealand was $1.13; however, it is not clear how the figure for New Zealand was derived.

Our low taxes overall may balance out those taxation incentives around R&D offered by countries such as Australia. For example, there have been recent reports that the presence of Capital Gains Tax in Australia is a major disincentive to investment. By contrast, New Zealand does not have such a tax and this should be more widely promoted to potential investors.

Must be no tax impediments to R&D

Table 6 *R&D tax treatment in OECD countries, 1996 incentive potential (B-index) (1)*

For every dollar invested it costs…

	Large firms	SMEs
New Zealand	$1.13	$1.13
Germany	$1.05	$1.05
Iceland	$1.03	$1.03
Norway	$1.02	$1.02
Portugal	$1.02	$1.02
Mexico	$1.02	$1.02
Sweden	$1.02	$1.02
Greece	$1.01	$1.01
Belgium	$1.00	$1.01
Finland	$1.01	$1.01
Switzerland	$1.00	$1.00
United Kingdom	$1.00	$1.00
Denmark	$1.00	$1.00
Ireland	$1.00	$1.00
Turkey	$1.00	$1.00
Japan	$1.01	$0.94
Austria	$0.93	$0.93
France	$0.92	$0.92
United States	$0.89	$0.89
Australia	$0.89	$0.89
Korea	$0.89	$0.81
Spain	$0.66	$0.66
Netherlands	$0.91	$0.61
Canada	$0.71	$0.50
Italy	$1.05	$0.41

Rather than move towards picking winners or supporting losers through the tax system, the principle of neutrality should be retained. However, Government needs to ensure two things, that the tax system is not creating any impediments to investing in R&D and that accurate data on investment in R&D is provided in order to decide whether the current system is in fact doing this.

Generally, information available suggests that New Zealand's R&D investment from the private sector is very low. A possible explanation with respect to tax is that, unlike other OECD countries, private investment in R&D in New Zealand is generally viewed as building capital assets for future income generation. As a capital investment, R&D in respect of information technology in the form of software can be depreciated over three years, while other forms of intangible property can be depreciated only if they come within certain specified categories of fixed life intangible property. However, full deduction for R&D expenditure is allowed for scientific research or where it can be demonstrated that development is directed towards ongoing modification of an existing product. The requirement to capitalise R&D investment may have a distorting effect and lead to under-reporting of R&D, or it may act as a disincentive to such investments. While this may have no effect in some industries, it may have a strongly negative effect on the software industry where there can be long lead times with some software development. If so, it will be a matter of some urgency to remedy it as part of New Zealand's advancement as a knowledge economy.

A survey of the world's top 300 international companies carried out for the UK Department of Trade and Industry revealed wide variations between countries in the amount spent on private R&D. The average investment was 4.6 per cent of sales. Denmark led the league table at 16.3 per cent, with Canada in second place at 10.8 per cent and Finland third at 10.4 per cent. US firms averaged 4.9 per cent, Japanese firms 4.8 per cent, with Italy at the bottom of the table on 2 per cent (*The Economist*, 1999a).

We must get the highest return from our R&D

Although the reforms in the science sector of the early 1990s have done much to improve the rate of return on New Zealand's investment in R&D, there is more that can be done. Are we spending our R&D dollars on the right things? New Zealand's approach, to create partnerships between public and private organisations to invest in R&D, has not so far been very successful. Is this the best approach to take? What can be done to increase the level of private investment in, and rate of return on, R&D?

Gallagher Group Limited – private R&D makes all the difference

Gallagher Group in Hamilton provides an excellent example of how a Kiwi company successfully uses its R&D expenditure to stay ahead of its global competitors. Gallagher Group manufactures electric fencing for agriculture and security purposes and is the world's No. 1 fence manufacturer in turnover, the variety of products, and people employed (320 staff in New Zealand and 450 overseas). The largest markets for its security products are the United States, South Africa and United Kingdom; for its agricultural products its primary markets are Europe (including Scandinavia), the United States, Japan, South Korea and Australia. The company has an Internet presence at http://www.gallagher.co.nz and much of its business is conducted electronically.

And the key to the group's success? Without hesitation Bill Gallagher, the CEO, cites research and development, which now accounts for 10 per cent of total production costs. Bill believes his commitment to R&D is greater than any of his competitors. Indeed, it was the slashing of R&D budgets by his competitors (140 in the 1950s and 3 major ones today) that saw the Gallagher Group overtake them. Bill Gallagher believes that R&D and education expenditure is where the New Zealand government could best contribute to development of a knowledge economy.

The company jealously guards its intellectual property, which includes 160 patents and more than 100 trademarks, and has defended them in court. His company receives very little government assistance but Bill Gallagher doesn't resent that. What he considers wrong is that New Zealand's agricultural products are required to compete in subsidised markets, which means this country does not receive the benefit of the low-cost efficient methodology it uses to produce its goods.

Bill thinks that New Zealand's education system is not preparing people appropriately for the commercial world. In his experience, newly qualified people don't know who the customer is. Bill is convinced that New Zealand cannot rely on a commodity-based economy as it has in the past. To survive commercially, New Zealanders need to identify and fill niche markets throughout the world and stimulate greater innovation.

A culture of innovation

Innovation needs a receptive culture

What makes some places of the world more conducive to innovation and job-creation than others? No amount of R&D and education will suffice unless there is a receptive culture. Culture does matter. Change-oriented, risk-loving cultures such as New Zealand would seem to have an advantage over conservative, risk-averse cultures such as Germany. The uptake of new technologies in New Zealand is more rapid and extensive than in conservative cultures. As *The Economist* noted in a special edition on innovation:

> English culture has had a strong influence in America, Canada, Australia, New Zealand and even Hong Kong as well as in the British Isles themselves. Yet these countries have vastly different track records in innovation – with America top and New Zealand probably bottom.
> (*The Economist*, 1999b)

Our natural innovation hampered by low R&D

New Zealand thinks of itself as having an innovative culture and is certainly a nation of early adopters. But as we have seen, our desire to innovate is hampered by our low level of research and development expenditure.

Part of the cultural question is how we regard entrepreneurs. Economist Joseph Schumpeter viewed the entrepreneur as an 'innovator', a person who brings a new idea to fruition (Schumpeter and Opie, 1936; Lee, nd). By introducing an innovation, the entrepreneur can temporarily capture most of the potential profits that exist in that market. But entrepreneurship involves taking risks. Schumpeter described an entrepreneur of a new type as someone who:

- operates well when markets are not clearly defined
- can discover economic opportunities and information
- can translate these into new markets
- builds new markets and expands old markets
- connects different markets
- is an 'input completer'.

Our firms are too conservative about new technologies

In Ernst & Young's 1998 survey of New Zealand's 500 largest companies, nearly 70 per cent said they tended to be conservative about adopting new technologies; that is, they adopted them late or went without them altogether. A startling 86 per cent of the chief executives surveyed admitted they did not know what percentage of their customers would prefer to do business electronically. In response to one question, 'In terms of new technologies, including Electronic Commerce, how do you see your organisation?' only 7 per cent said that they saw themselves as 'innovators' (Ernst & Young, 1999).

New Zealand needs to grow entrepreneurs, and encourage risk takers.

We need to encourage entrepreneurs and risk takers

New Zealand has been working actively to foster industry clusters as a way of promoting and focusing new business activity. A cluster is a group of companies with close trading relationships who have recognised the benefits of working together to overcome industry-wide problems or to take advantage of opportunities overseas (Nolan, 1999). Even as they compete for market share, businesses learn from one another through joint research ventures and shared best practices. Producers learn from their suppliers how to reduce lead times and eliminate costs. Each successful start-up attracts other start-ups, which in turn attract more capital and skills and yet more start-ups. Clustering fosters the law of increasing returns and creates virtuous circles of growth and prosperity.

Industry clusters support innovation

This has become increasingly apparent in the clustering initiatives in New Zealand. Wellington's telecommunications, film, multimedia design, and earthquake engineering clusters have set the standard. Dunedin now has a cluster for advanced imaging and video editing. Christchurch's electronics manufacturing and software cluster attracts brain-power and creates synergies. Palmerston North has its education and research cluster and Auckland its Silicon Bay on the North Shore. A strong set of clusters will grow around sources of competitive advantage in biotechnology, information, electronics and communications, materials and intelligent technologies, and will attract companies and people to New Zealand from all over the world (Industrial Research Limited, 1999). There is a positive correlation between competition and productivity growth among sub-groups of the economy, such as business clusters (Blundell, Griffith, and Van Reenen, 1995; Nickell, 1996).

Creating a venture capital market

Innovation helps attract global capital

Capital continually circulates in search of the best investment opportunities. Smaller, flexible economies such as New Zealand can attract capital seeking innovative business locations. Idea-driven innovation cycles in the knowledge economy determine an economy's position in the global hierarchy. The more innovative and intelligent a business location is, the higher its rank in the ladder of global investment. The ability to be on the leading edge of idea-driven innovation cycles determines one's rung in the global ladder of business locations.

Hi-tech innovation needs to be better supported by venture capital

New Zealand does not have well-developed venture capital and public capital raising markets, particularly for technology ventures. High-tech innovation has languished and ventures with excellent potential have been lost due to lack of business skills and properly applied capital. New Zealand is an innovation-rich but capital-poor country. 'Good ideas can stumble because nobody is prepared to provide finance or venture capital' (Bradford, 1999).

Few people in New Zealand are experienced in managing portfolios of IT venture capital investments. Our sharemarket and our banks do not value technology companies highly. According to John Blackham, NZ Intellectual Capital Foundation, 'The VC scene in New Zealand looks a bit like the Kalahari Desert. If there's risk involved, there are no reliable capital sources in New Zealand' (Sole, 1999). However, recent initiatives such as the No 8 Venture capital fund, managed by Morel & Co, and the New Zealand Stock Exchange's Hi-Tech venture capital market suggest a developing market is emerging. This market needs to mature quickly to make any significant difference to the current situation.

Some countries, such as Australia and the US, provide tax incentives to venture capitalists, such as being able to write off venture investment losses. Since 1981, Ireland's low corporate tax rate for all manufacturing companies and many export-oriented service companies, guaranteed until 2010, has attracted inward investment: 40 per cent of U.S. electronics investment in Europe since 1988 has gone to Ireland. Ireland now supplies 40 per cent of Europe's packaged software.

A private-sector solution, known as 'Innovation Market' or IM, has been pioneered in Sweden. In simple terms, IM allows the public to trade in venture capital projects over the

Internet. In Sweden, IM Managers help bridge the gap between innovation and finance, and embrace the entire business development process from the first business steps to listing. IM navigates growth companies around the failure/reconstruction cycle too often experienced in a traditional financing environment.

New Zealand's approach is to give overseas investors the very best business conditions, a sound fiscal and economic policy, and a flexible labour force. We must also provide the best conditions for venture capital to find innovative Kiwi companies.

Entrepreneurs must better understand the needs of investors

What else do we have to do to encourage a venture capital industry in New Zealand? Those who have capital to invest complain that would-be entrepreneurs seeking to borrow lack the necessary business skills, and expect to get loans without collateral and investment without having to give up equity. This suggests that local entrepreneurs need to have a better understanding of the venture capital system, while some kind of local conduit such as the IM is needed for small investors who want to put their money into new ventures.

Virtual Spectator – a VC model for leading-edge products?

Two companies, Terabyte Interactive and Animation Research Limited, have come up with an innovative product to provide computer animation and pay-to-view Internet broadcasting for the America's Cup challenge to be held in Auckland in 1999. Craig Meek of Terabyte and Ian Taylor of ARL came up with the idea during the 1995 America's Cup challenge. Virtual Spectator allows a home Internet user to experience the America's Cup races in real time through 3-D animation connected to global positioning satellite data. The graphics are on a CD-ROM while the positional data is transmitted over the Internet.

But Meek and Taylor knew that if they couldn't raise the money to develop the product it would remain just another good idea. The impetus for attempting to solve the problems was Louis Vuitton, the organisers of the Challenger Series, who asked Meek to come up with a new way to get more viewers involved in the racing. Meek and Taylor got down to business.

It was agreed that a joint venture company would own the intellectual property. But the biggest problem of all was procuring sufficient capital for development research even after the first version of the product was in use. The problems they identified were:

- loan finance and traditional equity funding were not options (because of the risk)
- the idea was so advanced that a market for it could not be assessed.

Venture capital or business angels were the only practical alternatives.

In January 1999 Meek and Taylor incorporated Virtual Spectator Yachting Limited and made 50 per cent of its shares available for venture capital investment. Venture capital firms even as far as the US expressed interest. The investors were entrepreneurs in IT-related industries. The idea was to cluster not only people who had money but also people who would be active directors providing business or technical expertise.

The company has already licensed its Virtual Stadium product to the Louis Vuitton Centre ready for the Challenger Series. The existing shareholders believe this idea will have world-wide appeal and they fully expect an international shareholding in due course.

Changing the export mix

Production and distribution of knowledge drives major OECD economies. We must know how NZ is doing

The economies of OECD countries are more heavily dependent than ever before on the production, distribution, and use of knowledge. Output and employment are expanding fastest in high-technology industries, such as computers, electronics and aerospace. In the past decade, the high-technology share of OECD manufacturing production and exports has more than doubled, reaching 20 to 25 per cent. Knowledge-intensive service sectors, such as education, communications, and information, are growing even faster.

Indeed, it is estimated that more than 50 per cent of Gross Domestic Product (GDP) in the major OECD economies is now based on the production and distribution of knowledge (OECD, 1996). Unfortunately it is not possible to get comparative New Zealand statistics in this regard. There needs to be an improvement of data captured in relation to the export value of knowledge-based goods in order for New Zealand to understand fully the present situation, and set goals for improvement.

We have too few hi-tech exports

Through the last decade the New Zealand economy has performed nearly on par with other OECD countries in terms of growth and productivity increases. But the export sector has failed to develop a high-tech segment similar to that of Australia, Ireland, and Finland. We continue to rely on commodity goods, such as agricultural products, for exports. In 1998 commodities made up nearly 50 per cent ($11.0 billion) of New Zealand's total exports of $22.3 billion, with agricultural commodities comprising around 30 per cent ($6.7 billion) of this (Statistics New Zealand,1999c). In contrast, New Zealand's IT hardware exports totalled $281 million (1.3 percent of total exports) while our exports of software and computer services amounted to $198 million, less than one per cent of all exports (March, 1999).

Primary sector products have relatively low rates of return for innovation. No matter how innovative our primary producers become, by competing in commodity markets, they will be unlikely to realise a high rate of return for their investment in innovation. In addition, commodity products are very vulnerable to changes in climatic conditions, the exchange rate and recessions in key markets. The value of our trade in commodities from December to February 1999, compared with December to February 1998, declined precipitously: wool by 22 per cent, paper and board by 24 per cent, meat by 10 per cent, and dairy products by 3 per cent (Statistics New Zealand, 1999c). For the managers of NZ Co., the issue is not how do we make this business more competitive, but rather how to reposition the company out of mature, declining markets into high-growth, sunrise markets. How can we create and foster our own equivalent to Nokia?

Internet will give our small firms access to international markets

New Zealand is a country of small firms: 85 percent of firms employ fewer than five full-time equivalents, 96 per cent fewer than nineteen (Statistics New Zealand, 1998b). The Internet is especially important in giving smaller firms access to international markets. It is the only cost-effective way for many such firms to engage in trade across borders. It is also important for larger firms, many of which now integrate on-line technology into their older proprietary electronic data interchange systems.

Electronic commerce increases market reach and decreases costs of maintaining customer contact

The evidence consistently points to some New Zealand firms using the Internet to increase exports. Some key conclusions of their experience are:

- electronic commerce applications are used far more intensively by exporting firms than firms supplying national markets
- these applications are the main way micro firms and most small firms can access overseas markets
- many small on-line firms export to several countries
- firms expect to export more, the more they use electronic commerce applications in their export activities because of increased market outreach and improved service standards
- no substitute exists for person-to-person contact in building a presence in overseas markets, but once established these interpersonal links are intensified and cultivated through on-line links.

Electronic commerce influences the direction of exports

Evidence is growing that electronic commerce influences the direction of exports. New Zealand's on-line links with Scandinavia are particularly strong, given its small population and relatively low historical importance to New Zealand firms and organisations. Links also are strong with other electronically enabled regions like North America and the UK. On the other hand, on-line links are much weaker with key trading partners in Asia, such as Japan and South Korea, which are not as electronically enabled as North America and northern Europe.

We still face particular challenges

Small, innovative companies in New Zealand face particular challenges that restrict their ability to grow internationally and to remain based in New Zealand. These include restricted access to venture capital, lack of funds to invest in research and development, and insufficiently skilled management. The New Zealand market is small, and international markets do not perceive New Zealand as a credible source of high-tech products.

Aspiring high-tech companies must focus on and understand the US market

Aspiring high-tech companies must focus on the US market to make an impact on any aspect of the global industry. But there are major challenges for New Zealand companies intent on achieving and sustaining success in the US market. It is important to recognise the central role that the US plays in the IT industries. The industries are centred there, as are the main markets, distribution channels, and strategic players. The US market is highly diverse and expensive to reach. Competition is intense, with most of the world's leading companies having a significant US business unit. The market is fast moving, and the business environment is more litigious than that of any other country. In considering their most appropriate strategy for approaching the US market, innovative New Zealand businesses need to appreciate these basic truths if they are to be successful.

The way forward

> Government policy approaches toward the Internet should start from two basic principles: avoid unnecessary regulation, and question the applicability of traditional rules
> (Werbach, 1997).

Internet opens up global markets

Throughout our history, New Zealanders have shown a remarkable ability to respond in a positive way to world events. Just as the first shipment of refrigerated meat aboard the *SS Dunedin* in February 1882 opened up new overseas markets for our primary products, so the Internet opens up new markets for our knowledge exports. These include such products as software, technology, education, film, television, Web design, telecommunications, financial services, call centres and others, all of which can travel down the information superhighways to the world at the speed of light.

The market must lead. The government's first job is to remove obstacles, and champion the way ahead.

New Zealand has a unique contribution to make in the global advance of the knowledge economy. The New Zealand way is to set the conditions for the marketplace to lead. If, despite all our best efforts, there are clear and demonstrable market failures, the government must intervene only long enough to set things right. When it becomes apparent that new markets have emerged elsewhere, and the conditions are not yet in place here for them to succeed in New Zealand, the government must step forward to remove the obstacles, and to champion the way ahead.

Setting out a vision and a clear direction

Leadership by government is vital for New Zealand to develop rapidly as a knowledge economy. In other countries, government leadership has been instrumental in the development of a knowledge economy strategy. In New Zealand, individuals and businesses look to government for leadership, for a clearly articulated vision and a sense of direction. They seek reassurance that as a country we are clear about where we are heading and how we are going to get there.

New Zealand's economic reforms have been predicated by a belief that the role of government is to create an environment where a fair competitive marketplace – unfettered by government regulation or incentives (or impediments) – will allow investment to flow to those areas of greatest return. The "level playing field" where government does not pick winners or losers.

Where government intervenes, the results must progress us towards becoming a knowledge-driven economy

However, it is clear that in regard to human capital development, no true market exists. The government is the only significant provider of education, and the most significant provider of research and development. In addition, government determines immigration policy. The key focus of many of these government interventions should be on advancing our progress towards the knowledge economy. By showing vision and active leadership in all the important areas, the government sends a powerful signal to people about how important the knowledge economy is for New Zealand's social and economic well being.

We must have a sense of urgency

Government's recent moves to gain the views of people in business, education, research, and local government on how to advance New Zealand's economy are a positive sign. However, much more is needed to create a national focus on developing a knowledge economy. Government leadership is essential if we are to catch up with the well-advanced knowledge economies. If the government is serious about getting New Zealand on the fast track to a knowledge economy, it must clearly and publicly articulate its vision of New Zealand's future and describe what we must do to get there.

We've won against the odds before ... we can again

New Zealand demonstrated its ability to compete and win the America's Cup at San Diego in 1994. Our yachtsmen and yacht designers are now sought by people and organisations from all over the world. Their knowledge and expertise are valuable intellectual properties that can be exported to the world just as effectively as our agricultural and horticultural products, for potentially greater return. Throughout our country one can find example after example of Kiwi ingenuity, differentiation, and knowledge that would have tremendous value on the world market, if only they had the proper marketing, financing, and management. New Zealand will take its place in the vanguard of nations that lead the world into the new millennium if we appreciate that our unique intellectual capital is marketable and if we commit ourselves to realising the value of their potential.

What must we do to meet the challenges? In the first instance, we must formulate policies to embrace and to exploit the potential of the knowledge economy. The government already intervenes in two key areas of the knowledge economy: education and research. Failure in these areas will result in slow development in all other areas. Failure to act at all will hinder our economic growth as well as our national interests. The stakes are high. If we fail, the fruits of the Knowledge Age will simply by-pass us. We run the risk of being increasingly marginalised. But the reward of success will be that we benefit fully from the global knowledge economy.

With total commitment, in less than 10 years we can be a knowledge-driven economy

If we were starting from the basis that Singapore and South Korea did, New Zealand's transformation into a truly knowledge-driven economy would be expected to take about ten years. However, given that we already have a good education and telecommunications infrastructure, and an open, competitive economy, we should be able to make much more rapid progress. Based upon our research to date, we outline the following components to a national strategy to support and accelerate the development of a knowledge economy in New Zealand.

Increase New Zealand's share of gross domestic product derived from knowledge-intensive industries

Our future economic success lies in innovative knowledge-based industries

- New Zealand's future economic success means reducing its dependence on commodity exports and increasing the share of its GDP in the innovative knowledge-based industries.
- We must invest in the knowledge-intensive sectors and train people young and old through high-quality education and life-long learning

In regard to information, we must:

  - Ensure that the tax regime is not a disincentive to investment in R&D;
  - Set a stretch goal for the contribution knowledge industries make to GDP.

Government to take a role in the development of a knowledge-intensive economy

Government must lead by example

The government's role is to lead by example. It must also challenge the private sector, the education community, and the research community to come up to the task. In particular, the government will need to:

- see education as the springboard for disseminating and implementing the knowledge economy strategy
- develop education policies to ensure that all students are exposed to ICT at an early age and that information literacy and computer skills are made a part of the national curriculum
- require all teachers to undertake fast-track courses in computer skills
- provide teachers with access to technology and on-going support to improve their skills and knowledge of ICT
- offer an approved course in information and communication technologies at Bursary level to encourage more students to enrol in IT courses at university
- fund extra places in IT courses at tertiary level to produce more IT graduates
- fund post-graduate scholarships in IT, perhaps through Technology New Zealand, to stimulate more post-graduate research in areas of special importance
- ensure that computer and Internet access are available to every student in a tertiary institution
- ensure that within five years all primary and secondary students have adequate access to a computer and Internet connection
- ensure investment in education enables Māori to develop skills to participate in the knowledge economy
- promote on-the-job and institution-based training to up-skill older workers in areas important to the knowledge economy
- explore ways of making an investment in industry training to increase the number of workers able to participate in knowledge-based industries.

Deal with the legal challenges

The Law Commission's discussion document on electronic commerce has gone a long way in canvassing legislative issues that might be impediments to the development of electronic commerce. Its final report, due in late August, will recommend any legislative changes. Government needs to implement such recommendations quickly to signal its commitment to electronic commerce.

Champion the development of a knowledge economy in New Zealand

Develop a clear vision and specific strategy

The vision of the knowledge economy, and the imperative for New Zealand to become one, must be stated and restated by all our leaders, so that everyone understands the challenge we face. In addition, the government must:

- ensure that it has a specific strategy for advancing New Zealand's progress towards becoming a knowledge economy, and determine the most effective public sector structure to ensure progress is well co-ordinated
- educate citizens on the nature of the knowledge economy
- encourage debate on how Māori and non-Māori knowledge can be used to advance national well being and give New Zealand brand distinctiveness that is universally valued
- establish and maintain the legal and regulatory frameworks for an information-based economy
- encourage private investment in knowledge industries, and encourage an innovation market to provide local sources of venture capital
- promote participation in international information society initiatives, such as the Fifth Framework networks, by becoming an Associate Member of the EU in the same way as Australia and Israel have
- launch a campaign to attract expatriate Kiwi knowledge workers to return to New Zealand
- review immigration policy to attract both permanent and temporary migrants with the right qualifications and experience for the knowledge economy
- support the creation of high-tech incubators for small and medium enterprises
- review our tax regime to ensure that there are no barriers to private investment in R&D.

We need partnership between all players, especially education and business

Finally, we must commit ourselves as a nation to a championing approach that brings together leaders in business, government, and education. New Zealand is small enough for us to be able to quickly make up lost ground. But we need to respect our innovators, our inventors, and our idea-generators, people working on the leading edge of change. We need all our politicians to be looking forward, to have the strategic vision, the understanding, and the experience to make the knowledge economy a reality.

Most importantly, we need an education system from which we can pull the skills that commerce needs of that system, not an education system that pushes unprepared students into the marketplace. Education needs help to understand what business needs. Without the assistance from business, teachers and schools will continue to design and implement coursework that does not prepare students for the real world of work. We need to look at our human resource as part of a 'knowledge supply chain'. The education system must support life-long learning. Population trends make it imperative that both young people and people of working age are encouraged and supported to engage in lifelong learning.

If New Zealanders do not seize the opportunities provided by the knowledge economy, we will survive only as an amusement park and holiday land for the citizens of more successful developed economies.

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