BUSINESS/HIGHER EDUCATION ROUND TABLE

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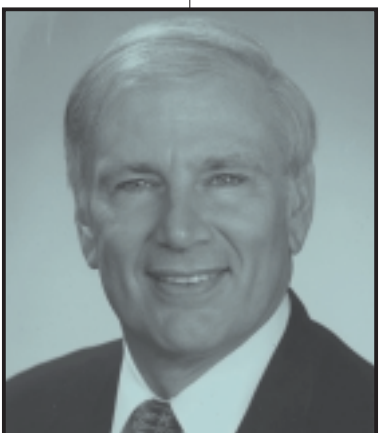
AUSTRALIA - THE INFORMATION ECONOMY

The new world of social and commercial interaction, brought about by advances in information technology, has come to be called the information economy.

Australia's future prosperity in this new world requires a cooperative effort on the part of all levels of government, the private sector and the general community if we are to capture potential gains in new markets, boost employment and small business activity and maximise innovation and creativity.



Senator
RICHARD ALSTON
Federal Minister for Communications, Information Technology and the Arts

No one could have predicted even three years ago the enormous pace of change and growth in this area, built upon rapid changes in information and communications technologies. How we exploit our key assets – knowledge, skills, creativity – using the new technologies that are becoming available to us will have a major impact on our future economic and social wellbeing.

Australians love new technologies. They are embracing the Internet, mobile phones, computer games and digital cameras with great gusto. Australians are highly IT literate, with one of the highest rates of Internet usage in the world.

More than 4 million adult Australians accessed the Internet in the 12 months to November last year – that's 31% of our total adult population. Some 19% of households are connected – an increase of 49% over the February 1998 figure.

Nations around the world are grappling with how to deal with the many unprecedented regulatory, social and economic challenges raised by the information age.

The government is guided by four principles in pursuing its mission for Australia in the information age:

- Australians need to be able to access sufficient and affordable communications infrastructure and services and need to be equipped with the skills and knowledge to harness the information economy's benefits;
- The role of government is to create the right environment – as a user of electronic services; to provide direction, education, training and encouragement to business and consumers; and to provide a secure and certain legal and regulatory framework;
- For electronic commerce to flourish, the private sector must continue to take the lead. The government encourages industry self-regulation, and supports the efforts of private sector organisations to guide the successful expansion of electronic commerce and to build confidence in its use;

- Because the information economy crosses national boundaries Australia is committed – and already working – to help develop a set of norms and conventions for international governance that accords with Australia's national interests.

A key element of the enabling framework is to ensure that the legal and regulatory framework encourages, rather than hinders, this process. We are well progressed in this regard, and expect to make further rapid progress in the next few months on issues such as data protection, digital copyright, authentication and content regulation.

There are huge opportunities for Australia from the Internet in applications ranging from electronic commerce to content provision and software development. These developments are transforming the way we do business and how we live our daily lives.

Government has a role to play in directly promoting the benefits of participating in the information economy to the business and broader community. 1999 has been designated as Online Australia Year, during which we hope to further boost participation by promoting the benefits of online technology to all members of the community. Information on Online Australia Year events and activities can be found on its central website located at **http://www.onlineaustralia.net.au.**

An effective way of boosting increased user confidence in online information and services is by example. All governments in Australia are using online technology in their day to day contact with people. I believe we can help to accelerate the uptake of new technologies by business and by the community generally by showing national leadership, and showing the way through best practice use to improve government business and services to the public.

"We must not only lead by example, but encourage growth..."

An example of the government as a leading edge user of online technologies is the Business Entry Point, (BEP) which provides a service to Australian businesses to make it easier to deal with government. Currently through the BEP businesses can access information on a wide range of government assistance programs and services, and business information on topics such as taxation, record keeping, superannuation, occupational health and safety, Customs, intellectual property protection and workplace relations. Businesses can also privately and securely undertake a number of initial business registrations. The BEP website location is **http://www.business.gov.au.**

An important area of building confidence in the use of these technologies is our work on the Year 2000 bug. We are well ahead of many parts of the world in relation to Y2K compliance. Our Year 2000 Information Disclosure legislation forms part of a coordinated response by the government, which includes tax deductibility for Y2K remediation software, a national awareness campaign for business and assistance to ensure that Commonwealth agencies are Y2K compliant.

We must not only lead by example, but encourage growth in the IT&T sector through supporting investment and research and development. The government has put in place an Action Agenda to support the ongoing development of our information technology industries.

The key priorities of the Information Industries Action Agenda are:

- Access to capital;
- Formation of intellectual property;
- A commitment to quality;
- The development of global scale;
- An orientation towards global markets; and
- The fostering of a domestic environment conducive to competitiveness, employment and growth.

Further information on the Action Agenda can be found at: **http://www.isr.gov.au/infoind/busonline/iiaa.pdf.**

The information economy is a global economy, redefining trade barriers and changing the ground rules almost daily. Australia is active in international fora, to ensure that global frameworks in this area achieve our national interest, and do not act as a break on advances in Australia and at the global level.

As Business/Higher Education Round Table members are most certainly aware, a key element to our transition to a knowledge based economy is education and training.

Australia has long been recognised for its high skills base, and its highly educated workforce. Our human capital has been highlighted as one of our greatest assets. A sound skills base can be an important comparative advantage.

The need to provide the skills that Australia requires is one of the most important priorities identified in the Australian Government's national blueprint, *A Strategic Framework for the Information Economy* released in January 1999. **(http://www.noie.gov.au).**

These skills cover not just the technical skills required for the IT & T industries, although these are crucially important. They also encompass the skills required for participation at all levels throughout the community. The acquisition of skills for the information economy is the currency of the next century.

Australia, like many other countries, is experiencing some effects of the global IT&T skills shortage.

That is why all levels of Australian government are working closely with the IT&T industry and the education and training sectors to increase the supply of skilled workers both now and into the future.

This will be achieved by providing a more responsive education and training sector, establishing stronger links between government, the industry and education and training institutions and encouraging greater industry investment in improved career and training opportunities.

In our move to the information economy, one message is clear to governments, the education sector and business – change is inevitable, and we must keep moving ahead to respond to the global challenges that will continue to emerge.

'knowledge economy' and the implications for business, universities and government.

Dr Roland Williams,
President BHERT & Chairman/
Chief Executive Officer, Shell Australia Limited

PRESIDENT'S MESSAGE

The theme of this edition of BHERT NEWS is 'the knowledge economy'.

Increasingly, knowledge-based industries are becoming a key part of our industrial landscape. And in more traditional industries, intellectual value-added is now a major driver of overall performance.

How Australia positions itself to maximise on the opportunities of the knowledge revolution will be critical to our future standard of living. This will require close cooperation between business and universities. It will also require commitment from our governments.

The articles in this edition examine the nature of the emerging 'knowledge economy' and the implications for business, universities and government. I hope you enjoy this thought-provoking edition of BHERT NEWS.

THE KNOWLEDGE ECONOMY OF TOMORROW

PROFESSOR ASHLEY GOLDSWORTHY
AO OBE FTSE FCIE
Executive Director Business/Higher Education Round Table

As we enter the new millennium, the fundamentals of developed economies are undergoing radical transformations. Our traditional industries are being replaced. Knowledge-based industries are becoming the primary engines for growth in our economies. Knowledge underpins innovation and innovation drives the constant regeneration of industry. We now speak of the *learning economy*.

"Knowledge" is different from "information", and the "knowledge economy" is different from the "information economy" - and both are very different from "information technology". Governments as well as business need to become much more sensitive to the differences.

Knowledge requires understanding, ordering and recombining. We need to have not only know-how, but also know-what, know-who, know-when, know-why and know-where.

However, knowledge by itself is not enough. It needs to be married, both at the level of the firm as well as at a national level, with high level skills in management, marketing, distribution, manufacturing, and customer support, enveloped in aggressive leadership, if innovation is to enhance performance.

Economies / markets / nations are facing increasingly stiff competition, and all have choices as to which route they want to take. It is this choice which is critical to the future well-being of this country. Our future **must** be in well-paid jobs in the knowledge economy. However, this requires some positive leadership and decisive actions by leaders in both government and business to position Australia to benefit from tomorrow's high-tech world.

What does the current national balance sheet look like? In recent years there had been a marked increase in business expenditure on R&D (BERD) - especially since the 150% tax concession in 1985 (which unfortunately has declined significantly since the concession was reduced to 125% in 1996); in some sectors such as electronics, shipbuilding, and metal industries our R&D is above OECD averages, despite our total BERD being below OECD averages; our exports of knowledge intensive manufactures have increased sharply; we have seen more collaborative linkages e.g. CRCs; we are putting more emphasis on training and productivity; and our services sector rates highly in international comparisons in terms of R&D.

A Business Council of Australia survey last year (which has not been released) is reported to show a 3% decline in industry spending on R&D in 1996/97, an estimated decline of 5% in 1997/98, and an expected plunge of 23% in the current year. This represents a reduction of more than $1.5 billion in R&D expenditure.

In the previous five years, industry R&D spending had been increasing at an average rate of 16% per annum.

The BCA survey shows that the growth pattern turned with the reduction in the R&D concession from 150% to 125%. This suggests that R&D spending is very sensitive to tax-concession assistance.

On the other side of the ledger we are operating substantial *and growing* trade deficits in more knowledge intensive, more innovative industries and our terms of trade are biased towards the less knowledge intensive, less innovative industries - we are going in the wrong direction; our employment seems to be shifting to lower paying and lower skilled jobs; our R&D performance in medium-high tech industries such as automotive remains poor by world standards; as indicated above we have a propensity for reduced R&D; a largely low-tech manufacturing sector; deteriorating public infrastructure; a very risk averse investment mentality; export/import ratios that have shown no improvement in the four decades from the 1950's to the 1990's; and a taxation system that is a major disincentive to investment.

The Managing Director, Research & Technology Development, of Rio Tinto, Dr. Robin Batterham (and recently appointed Chief Scientist), in a submission to the enquiry by the House of Representatives Standing Committee on Industry, Science and Technology, last year emphasised the significance of the tax concession for decision making by large corporations.

He said, "The two changes which have had the greatest impact on Australian corporate R&D strategy over the last decade have been the introduction of the 150% tax concession in July 1985 and the reduced concession to 125% in August 1996. The reduction in taxation incentive from 150% to 125% has a much greater negative effect than the reduction per se would seem to indicate. In the eyes of some managers, the scheme does not change from being attractive to being less attractive but to being not attractive at all because the administrative cost of compliance, in time and dollars, is simply too great to justify the taxation return."

He made the point that, "The symbolic value of the tax concession should not be overlooked. It ensures that R&D is discussed at the highest levels within an organisation and it creates an awareness amongst senior management of the need to consider R&D in the total business context."

Mr Tim Besley, President of the Academy of Technological Sciences and Engineering, in an address to the Australian Defence Force Academy in May 1998 said, "Another regrettable action of the Government was to reduce the R&D taxation concession to 125% and to tighten the eligibility criteria. These twin actions have greatly reduced the value of the concession to business and may well have placed in jeopardy the recent gains in stimulating business R&D."

There is little doubt that much needs to be done if we hope to reorient the economy to one that might be regarded as a learning economy in which the prime drivers of economic growth are knowledge production and diffusion.

...we are going in the wrong direction; our employment seems to be shifting to lower paying and lower skilled jobs;

The issue is of course, What needs to be done? We need a framework of government policies which recognises the critical importance of knowledge based industries and provides leadership in steering the country in that direction. An absolute sine qua non is radical reform of the taxation system, which would help to attract rather than repel investment and encourage R&D. We have to do everything we can to encourage knowledge and innovation intensive industries at the cutting edge of research.

Three actions that must be taken if Australia is to have any hope of competing internationally in attracting and developing knowledge-based industries are:

(i) a radical reform of our Capital Gains Tax regime (both in structure and rate) to make it internationally competitive,

(ii) reintroduction of the 150% taxation concession (or something of equal benefit - but more targetted and focussed) for R&D,

(iii) greater investment in universities to support the additional research and graduates needed to provide the skills base required.

Without these we are wasting our time.

TECHNICAL INNOVATION IN AUSTRALIA

The following are extracts from an unpublished paper by Dr B Lucarelli, Department of Industry, Science and Resources, Canberra, January, 1999. The complete paper should be read to understand the context in which the extracts occur.

…despite the quite impressive performance over the past 10-15 years, Australia still lags behind the key OECD indicators and is experiencing serious structural problems most evident in the declining terms of trade which could act as a powerful brake on future growth prospects and inhibit the process of economic restructuring required to take advantage of globalisation and the shift to the knowledge economy.

- BERD has nearly trebled over the past 15 years as a result of various industry assistance measures such as the 150 per cent tax concession for R&D expenditure, the Partnership for Development program and other R&D syndication programs.
- The R&D intensity of Australian industry sectors is still well below OECD averages, especially in the high tech and medium high tech industries.
- A common trend throughout the OECD has been the shift away from traditional manufacturing and towards service industries. There has been (in Australia) an unfavourable bias toward the low value added and low skilled service industries like tourism and hospitality.
- Australia's terms of trade have experienced a spectacular decline. In stark contrast, the OECD has experienced a shift toward more knowledge intensive exports. In the 16 leading OECD countries, manufactured exports account for 56 per cent of total exports on average. Manufactured goods in Australia only account for 18 per cent of total exports. Almost two thirds of Australia's merchandise trade still consists of primary products; a ratio comparable with middle income developing economies like Argentina, Brazil and Mexico.
- In 1997-98, the trade deficit in ETMs was estimated at $49 billion. If the present trend continues, the trade deficit in ETMs is expected to more than double over the next decade, estimated at about $A100 billion in 2010 at current prices. One stark consequence of Australia's growing trade imbalance is the forecast in the recent Goldsworthy Report that the trade deficit in information technology alone will be about $46 billion annually by 2005.

To reverse this structural decline, a more sophisticated and strategic industry policy is essential. It is imperative that industry policy focuses on redressing these structural weaknesses and providing the basis for a shift towards the high value-added and high technology sectors. A more innovative, technologically driven industry policy is therefore essential to promote the expansion of high wage employment and provide the productivity edge, which will contribute to an improved international competitive advantage.

To be competitive in the global economy, it is essential that the national system of innovation be improved and strengthened. New forms of policy co-ordination, involving both new structures and new initiatives are necessary if governments are to be able to navigate the transition to the emerging knowledge economy.

Australia's international competitiveness depends on making the most of our distinctive and valuable assets, which competitors find hard to imitate. In the modern economy those distinctive assets are increasingly knowledge, skills and creativity rather than the traditional factors such as land and other natural resources. In a knowledge-driven economy, partnership is essential to effective competition. To exploit our capabilities in human resources and technologies, firms have to collaborate across sectors, throughout regions and with the national innovation system. Sectoral partnerships, including supply chain initiatives, networking and clusters play a critical role in sharing knowledge and upgrading skills among complementary businesses.

TODAY'S SCORECARD

	AUST	OECD
BERD (% of GDP)		
High Tech	16.5	22.3
Med-high Tech	3.8	10.5
Med-low Tech	4.4	3.5
R&D Intensity (%)		
Pharmaceuticals	13.9	22.5
Electronics	22.7	20.3
Aerospace	8.3	28.4
Motor Vehicles	5.0	13.2
Chemicals	2.9	9.1
Elect. Machinery	2.7	6.8
Manufactured Exports		
% of Total Exports	18	56
Export Orientation of Manufacturing (%)		
High-tech	21.2	30.2
Med-high tech	11.2	28.6
Med-low tech	9.6	19.8
Gross Domestic Expenditure on R&D as % of GDP	1.6	2.6(US) 2.3(Germ) 2.3(Fran) 3.6(Swed)
BERD as % of Business GDP	0.9	2.1(US) 1.9(Germ) 1.9(Fran) 3.9(Swed)

KNOWLEDGE – THE INDUSTRY OF TOMORROW

There is something compelling about the prospect of the 21st Century and the dawn of the new Millennium. What an opportunity to clear the decks of outmoded concepts, business models and institutions and move forward with the right framework to reap the potential and excitement of a new age.

At a time of great change, one certainty is that, far from abating, the globalization and information revolution already underway, will gather momentum. Those countries and businesses that take the opportunity, will create wealth and employment. Those who don't will run the risk of being marginalised. The key to success in the global economy is recognising and exploiting the information revolution.

In the last twenty years, technology and globalization have transformed the world from a collection of closed national markets into an integrated global market for goods, services, capital, and, increasingly, skills. This poses major challenges for business, government and training institutions.

The information revolution has changed the rules and business models and introduced competition from new players. Skills, knowledge and intangible assets are now the source of strategic differentiation, and universities and educational institutions are at the centre of this dynamic shift.

The Knowledge Business

For the past decade, businesses have undergone an unprecedented renovation program. Globalization has driven a corporate housekeeping spree that has impacted every industry sector and shaken governments and other institutions.

Those who have ridden this wave are now looking to leverage the efficiency dividend and create wealth and opportunities from new and emerging industries.

The new focus is on growth, and the key to growth is information and knowledge. For all industries, learning, knowledge and innovation will be the key to shareholder returns.

Of all sectors, the impact on service industries will be most profound. Already we are seeing the service sector dividing into those functions which are transaction based and those which are knowledge based. Rewards and competition will move to the high value end – the knowledge based services.

Service industries also hold the key to adding value in other sectors, mining, agriculture and manufacturing. These changes are accompanied by profound organisational change. Although in Australia this is not occurring fast enough we are starting to see the impact of business-to-business e-commerce and very early online applications.

Knowledge workers operate and flourish in a business environment that is vastly different from traditional hierarchical and structured work places. These workers are flexible, dynamic and project or deal oriented with a high level of individual autonomy. Increasingly, the new dynamic organisation is built around teams, which are project focused and operate on functional lines, across national boundaries.

A key challenge for the knowledge business is having leaders and managers who themselves understand and are energised by this new environment and can motivate and leverage the skills of these workers. In recognition of this shift, Directors will be required to concentrate on intangible and human assets with the focus they have placed on tangible assets in the past.

The Knowledge Worker

The information revolution has created a new group of wealth creators. They are those who can manage technology and information to create new markets, innovative products and distribution channels.

Knowledge workers belong in all industries and all sectors. They are the key to forming new emerging industries. Traditional industries will also use knowledge workers to stay in business, and add value where competition would otherwise erode their markets.

Knowledge workers do not come neatly labelled medicine, science, tax, audit, legal, technology or management.

Knowledge workers have a range of skills and personal qualities that go beyond technical or professional skills. They are savvy, street smart individuals, able to work in multi disciplinary and multi cultural teams and are sensitive to international environments. They are also richly remunerated and this trend is likely to continue as long as they are in such short supply.

MS JUDITH KING
Chief Executive, Australian Services Network

Knowledge workers take technology and information to new levels of value for the business. They go beyond "off the shelf" products and create new markets through innovation, and customer focused solutions. Far from living and functioning in laboratories or work places remote from the market place, they are immersed in the business world.

The Knowledge Industry and Government

Government is an important partner in the information economy, a fact recognised by the assertive policies coming from the United States, Europe, Malaysia, Israel and Ireland and an increasing number of other countries.

The Victorian government has delivered a suite of imaginative policies and initiatives and other States are moving in that direction. It is the Federal Government however that must provide leadership if Australia is to compete in the online world.

As a major supplier of health, education and community services, Government can be a leader; accelerating the transition and building confidence in online delivery, thereby cutting costs and improving access to services. Government is also critical in ensuring that policy encourages rather than impedes the information economy.

The knowledge economy will only thrive in an environment that is visionary, flexible and risk taking. Infrastructure must support individual ventures and ensure that business can compete. It requires investment in skills and innovation, recognises and rewards entrepreneurship and creativity. The tax and regulatory environment in the new economy must be built with the same sense of purpose as applied to emerging industries in earlier times.

Australia has traditionally viewed policy through the resource and commodity filter, but knowledge and service industries are different to other sectors, and a new mindset is required.

Only recently has the question of skills surfaced as a major issue linked to the new economy. Even so, the emphasis to date has been on technology and computer skills. While they are needed, and needed urgently, in the long term the returns will come from investment in knowledge and content creation skills. A substantially higher level of national priority must be attached to this agenda. Recognising and applying the new mindset is the biggest challenge for government.

The Knowledge Industry and Education

In an era where knowledge is the currency, universities are in a winning position to develop and unleash intellectual property in a highly competitive market. This is their business. It just happens now to be also the business of a growing number of new players.

Skills are the raw materials – the absolutely critical resource of the knowledge economy. Universities and educational providers have a head start in a booming business. They will have to rapidly adjust to new demands if they are not to lose to new players and competitors.

The knowledge industry is driven by continuous demand – a good thing for any business. The demand for new ideas, new skills, new perceptions of markets, new technical skills and solutions is ongoing.

The challenge for universities is to maintain the quality and integrity of their courses while at the same time adopting the flexibility and management practices demanded in the market at large. The challenges include:

- Becoming much more skilled at negotiating with business, conditions covering contract research and training. Researchers work on a different time frame to business, but if business is to be able to draw on a growing cadre of PhDs as happens in other countries, programs which are more flexible and innovative will win over those which are not. Courses will include a much broader sweep of options, technical, social and business related.
- Switching from the mass market for tertiary education to niche markets.
- Turning competitors into partners. Supplying skills into the knowledge economy is big business, and competition is reflecting that.
- Universities will also have to adjust to lifetime learning with more flexibility. Individuals who are part of knowledge industries will continue to acquire knowledge as a norm. They will look for solutions from institutes of learning that treat them as a customer – and create courses for the market of one.

The knowledge business thrives on networking, alliances and global partnerships. Networking and international collegiality are central to academe. Academics are acutely aware of competition, peer performance and leading edge research within their immediate area of expertise. But academic networks have in the main been closely guarded secrets, and individual academics a largely untapped resource.

In the knowledge industry, much greater use will be made of these networks. Not only will entrepreneurial academics use their networks and colleagues to deliver courses in traditional classroom format; virtual networks will make the expertise of leading academics much more widely available. For the best; the world will be their market. At the same time, poor performers will find their classes quickly dwindle – and their funding sources disappear.

It is the United States that has placed a premium on links between business and universities. It is the United States that is leading the world in creating the knowledge economy. Australia would harvest a fast return if the expertise in universities was unlocked and the depth of knowledge available channeled into new enterprises and the knowledge economy.

Australia has a great deal at stake in the knowledge and online economy, not least being the opportunity to bridge the geographic and distance barriers to reach new markets. We have advantages to ride this revolution. But the knowledge industry is fast moving and will leave slow movers in its wake.

Reference

McKinsey & Company/Australian Coalition of Service Industries, *australia.com: Australia's Future Online*, March 1997.

WHAT THE REST OF THE WORLD IS DOING

The following case studies demonstrate that there is a paradigm shift taking place in many OECD and leading Asian countries at the highest levels of government. It is the realisation that knowledge and its application is now the major driving force of economic performance and that there is an important facilitation role for government consistent with the diverse and dispersed benefits of public investment in the generation and diffusion of knowledge.

The case studies have been extracted from a briefing paper prepared by Professor Deane Terrell, Vice-Chancellor, Australian National University, and submitted to the Prime Minister and related Federal Ministers in early March, 1999.

UNITED STATES: continuing the tradition of commitment to basic research

Since WWII the US has maintained world leadership in basic research.

Support for non-defence R&D has fallen from 1% of GDP in the 1960s to 0.4% in the 1990s. Federal Budget share of non-defence R&D has fallen from 5.7% in 1965 to 1.9% in 1997.[1]

It is notable that in this environment the basic research share of Federal R&D support has increased from 18% in 1992 to 21% in 1997.[2] The NSF budget, representing a significant share of basic research support, increased in 1999 by 7.1% and the 2000 Budget request is for a 6.9% increase. The National Institute of Health budget increased 15% in 1999 and the budget request for 2000 is for a 2.1% increase. This is largely explained by the fact that the US administration and legislature continue to express strong support for the public funding of basic research as a key to the nation's future prosperity.[3]

UNITED KINGDOM: major funding boost for S&T, measures to strengthen innovation

In 1998, the UK Government has announced £1,107 million additional funding from Government and £400 million from the Wellcome Trust for research infrastructure and research grants in priority areas over the three years from 1999-2001. The British Prime Minister has noted[4] that his government has found new money for science and the universities because the UK's future success depends on knowledge and innovation.

The 1998 Competitiveness White Paper, *Building the Knowledge Driven Economy*, states the policy framework and announces the funding required, including the above funding, for strengthening capabilities, encouraging collaboration and promoting competition.

JAPAN: a long-term commitment since 1996 to increased public investment in basic research

Japan provides the most striking example of recognition that importing knowledge and building high technology industry through applied R&D is not a sustainable strategy for economic growth and prosperity. Despite Japan's enormous success in the 1970s and 1980s based on the earlier strategy, it is now widely recognised in Japan that current US ascendancy in technology based economic performance is due to its long-term commitment to basic research.

The Japanese government has responded to this new understanding of the crucial role of basic research by enshrining the Science and Technology Basic Law. The S&T Plan of 1996 based on this Law has committed Japan to doubling its investment in basic research between 1996 and 2000. Total R&D spending by the Japanese government in this period is a projected ¥17 trillion or US$155 billion. The Japanese government's budget decisions for 1999 confirm that the planned increased investment is on track despite the considerable difficulties experienced in recent years by the Japanese economy.[5]

SINGAPORE: leading the world in competitiveness ranking by integrating knowledge, technology, infrastructure and business

The World Economic Forum and the World Competitiveness Scoreboard of the Institute for Management Developments consistently rank Singapore first or second in the world in competitiveness measured on the basis of a range of factors including science and technology and infrastructure.[6] Singapore now boasts over 60 research scientists and engineers for every 10,000 persons in the workforce, ahead of most OECD countries. Underpinning these achievements is a long-term commitment to public investment in science and technology.[7]

In the year 2000, Singapore will conclude its second 5-year S$4 billion National Science and Technology Plan. Singapore has also announced plans to build a S$5 billion Science Hub. The decision to build the 176 ha facility, in addition to the two science parks in existence was announced last year. When completed it will be the home for over 200 high technology companies and will include the presence of world class institutions such as INSEAD and Johns Hopkins University. Singapore also continues to make strategic investment in research infrastructure. It has announced plans for a second major national high performance computing and communications facility and a new synchrotron light source to be used by both academic and industry researchers.[8]

SOUTH KOREA: commitment to S&T in the face of financial adversity

Despite the severe impact on South Korea's economy of the recent Asian financial crisis, its government has approved a five-year Science and Technology Innovation Plan designed to increase government-funded research and development to boost economic growth. The South Korean government will increase R&D expenditure from 3.9% to 5% of total

WHAT THE REST OF THE WORLD IS DOING... *Cont.*

government expenditure by the year 2002. This is an increase of at least 28% in a four-year period.[9]

CANADA: transition from commodity export to high-technology industry

Science is playing a key role in Canada's transition from an economy dependent on commodities and exports to one based on knowledge and technology. During this momentous change, the country is experiencing shortages – sometimes acute – of scientists in fields ranging from computing professions to information technology to health and biotechnology.[10]

It is widely expected that the Federal Government of Canada will allocate some of its substantial budget surpluses, an estimated Canadian $70 billion, as investment in science and technology. Canada has a major concern in relation to losing its highly skilled workforce to more attractive employment opportunities south of the border in the United States. The increased investment in science and technology is in part being directed to create incentives to retain the highly trained younger Canadians in employment within Canadian research institutions, government and business.

FRANCE: major investment in science and education for the third millennium

The French Government in 1998 announced plans for a higher education and research development project to be called the University of the Third Millennium (U3M). U3M will be organised along the same lines as the earlier program University 2000 (U2000) with a funding level of FF42 billion (US$7.4 billion). U2000 resulted in the construction between 1988 and 1992 of about 1.3 million square metres of university space. The new U3M program will be funded to at least the same level as the U2000 program and will focus on research infrastructure including high-speed computer networks and new biotechnology centres.[11]

GERMANY: promotion and funding of research a top priority of the new government

In January 1999, the German Cabinet has provided an additional DM904 million in the Budget of the Federal Ministry of Education and Research, a 6.4% increase on the previous year, declaring the promotion and funding of research to be one of its top priorities. The government has appropriated DM3 billion to supplement current S&T projects and to establish new strategic research projects in the areas of health, employment, work and technology design, biotechnology, information technology, environment, and transport.[12]

German industry reduced investment in R&D during the first half of this decade and reversed this trend increasing investment between 1995 and 1997 by 10%. The government believes that a better performance on investment in R&D is required for Germany to make a successful transition to becoming a knowledge-based society. The additional public investment is in part intended to stimulate further investments from German industry.[13]

FINLAND: a knowledge-based society

The Government of Finland considers that knowledge and know-how are central to economic growth, employment and social welfare. They create a basis for better income and intellectual growth.[14] Consistent with this approach, Finland has consistently increased its total R&D expenditure from both public and private sectors since before 1985. As a proportion of GDP, expenditure on R&D in Finland has risen from about 1.5% in 1985, to 2.35% in 1995 and 2.7% in 1997. The Government's goal is to increase R&D expenditure to 2.9% of GDP by 1999.[15]

Government support for R&D through Tekes, Technology Development Centre of Finland, substantially increased in 1997 over the previous year. In information technology, 1997 funding is FIN611 million, a 37% increase on the previous year, and in biotechnology, chemistry and environment, funding is FIN535 million, a 74% increase on the previous year.[16]

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DOES THE KNOWLEDGE BASE OF TODAY SERVE KNOWLEDGE – THE INDUSTRY OF TOMORROW?

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In the future, companies will build their success on the ownership or use of some sort of knowledge. The wealth of countries will also be built on knowledge.

Knowledge is what turns raw materials into marketable products. Knowledge is creating new materials and new types of products and processes. In many cases, knowledge itself is the product. Commodities that do not contain knowledge are worth very little, to importers and to consumers, and are declining in value.

On the other hand, clever products are precious and profitable. When products embody knowledge, the copying of that knowledge is often cheap. In a CD-ROM of the *Encyclopaedia Britannica*, retailing at about $200, the raw material from which the disk is fabricated might cost about $1 and reproduction might cost another $1. The rest of the value is knowledge. So if you have the knowledge, its cost of replication is in many cases almost nothing.

For a car, the cost of production is a much greater part of the final price. Even so, knowledge – incorporated into clever materials, aerodynamic design, lean production methods and computerised driving controls – is increasingly adding value to cars.

In agriculture, biotechnology may soon increase the knowledge that goes into growing the food we eat; indeed, the biotechnology revolution of the 21st century will over the medium to long term be profoundly transformational of world society.

There are other areas of knowledge where advances have profound implications for our future. Examples include materials science and nanotechnology.

However, in this short paper I will concentrate on one area of knowledge that is also a key technology-computing and communications technology.

The lessons to be drawn from computing and communications technology could also be drawn, in very similar terms, from other areas of scientific and technological growth.

For most of this century, as people have moved from the country to cities and from factories to offices, service industries have been the fastest growing part of advanced economies. Knowledge is almost the defining characteristic of a service industry: think of stock brokers, travel agents, traders and the professions. One of the largest service industries of all is government, which is nothing if not a producer and user of knowledge.

The tool that has been used to apply knowledge to every area of business and government, and which as a result has become a major industry itself, is the computer. It is the most pervasive tool in modern society: farming, mining, manufacturing, banking, airlines, education and public services - all depend on computer hardware and software and communication networks.

On a scale of intelligence that goes from data, through information and then knowledge, to wisdom, computers have progressed from processing data to handling

information, that is, organised data. In limited areas, such as medicine and law, inventors assert that their expert computer systems have knowledge. No computer system yet exhibits wisdom.

But computers and communication are the key technology of the information revolution. In a decade or two, the most successful companies will be those which manage knowledge the best, and much of their success will be based on computer systems which are knowledgeable i.e. in some ways mimic human reasoning processes. The beginning glimmers can be seen, in medicine and law as mentioned above, and in technologies such as data-mining. The internet search engine company, Yahoo, was recently valued by the stock market at billions of dollars – and in comparison with the knowledge engines we shall see in a few years, it is primitive.

Acquiring and using new knowledge of course means research, development and training involving a broad range of disciplines. But as well as discovering smarter processes and products, we need to find out how people gain and use knowledge within an organisation. In part reflecting the process of organisational flattening, but also because of its intrinsic value, the future outstanding companies will need the capability to extract and store tacit knowledge or relevant experience from their individual employees, and organise it into a framework that makes it easily accessible to others in the organisation to enhance how they can work. Today this is impossible, for we lack a workable theory of knowledge which embraces its representation, manipulation and transmission between one machine and another and between machines and people.

Because of the huge investment all industries are making in knowledge, information technology and telecommunications are forecast to become the largest sector of economic activity worldwide. If the same thing is to happen in Australia in a manner that confers the full benefits on our citizens rather than foreign shareholders, we have to act decisively and deliberately. A precondition to stay at the forefront of a knowledge industry, like any other, is research in its underpinning technologies.

In September 1998 the Australian Research Council published a review of the Australian disciplinary research base in information technology, prepared by the Australian Academy of Technological Sciences and Engineering, called *Information Technology: Sink or Swim*. This report sounds not just a muted alarm bell, but a deafening siren for Australia, a siren directed at governments, universities and business. The report says, in relation to our IT research capability, 'We are going backwards.' And at the same time the report notes that the ratio of IT imports to exports is 4:1 against us and worsening.

As the preface to the *Sink or Swim* report states, 'Either Australia embraces the Information Age wholeheartedly and moves towards a prosperous future in the 21st century or it continues to rely on primary industry exports to be able to import the high technology products which are so enthusiastically consumed. If Australia chooses the first option and 'swims' with the tide, it can join other countries like Ireland, Israel, Finland, Sweden and Taiwan…But if Australia continues down its current path, it will 'sink' in the face of ever increasing competition from emerging nations in agricultural and minerals markets.'

What are we failing to do? The report dwells mainly on the failures in training and shortcomings of the disciplinary research base – other reports have dwelt on the industry structure. First, Australia is moving backwards, relative to its competitors, in terms of the supply of professional IT staff and trained researchers for business and academia. The *Sink or Swim* report says that the number of computer science graduates needs to be increased, with six times as many postgraduate students by 2010! This newsletter has published figures (June 1998) showing that in 1992, compared to Australia, Japan had four times as many engineering graduates as a percentage of total graduates; it would be no surprise to see a similar figure in information science and technology.

…moves towards a prosperous future in the 21st century or it continues to rely on primary industry exports to be able to import the high technology products…

Having qualified people for research and industry makes up one part of the supply chain. Maintaining the intellectual pace in the universities and CSIRO is another. *Sink or Swim* says our position in IT research and development is declining *relative* to other countries. Business research performance in the IT area is low and university research groups often lack a critical mass.

Many recent government actions have not helped. We have a government which significantly attenuated the financial attractiveness for industry to engage in research and development, notwithstanding the endorsement by the Industries Commission of the economic rationale in public funding of R&D tax concessions, given the spillover benefits. Unfortunately this has also occurred when international surveys have demonstrated the significantly lower priority given to innovation by Australian company executives as compared to their foreign counterparts.

The government has also increased the price of a tertiary science or engineering education relative to the humanities.

Nevertheless, the Federal Government has initiated one significant development recently: setting up the Australian Partnership for Advanced Computing, headquartered at the Australian National University. This is a consortium of Australian universities established to operate a high-performance computing facility for research, training and the diffusion of techniques to industry.

Another round of Cooperative Research Centre grants will be decided in the near future. All the proposals for new IT cooperative research centres were knocked out in the preliminary screening. The only way to maintain the rather low level of IT research conducted through the CRC program is for all the existing centres seeking renewal to receive funding.

Governments have known for a number of years, through a variety of reports, that computer science as an intellectual discipline in Australian universities is weak. Both Labor and Coalition governments have been unable to create policies to fix an area of national importance.

There seems a lack of systematic policy instruments to address the problem. The Australian Research Council cannot do it: its job is, broadly, the support of excellence. The Australian Partnership for Advanced Computing is confined to a small disciplinary area. The Cooperative Research Centre program is not designed to build up weak but important areas.

These problems have been exacerbated by the substantial lowering of government appropriation funding for universities, especially when computed on a per-student basis. Because of the comparative sparsity of local outstanding academic talent, universities have desperate need of some outstanding talent from abroad in the IT area. The universities must have sufficient money to attract distinguished individuals to nucleate centres of excellence.

The starting salaries offered by industry to bachelor computer science graduates tempt them away from further study. To train the most talented graduates for research, we need to offer more attractive postgraduate scholarships in selected disciplines. A recent Government move to offer 50 new post-graduate industry-linked scholarships is welcome, but obviously only a small component of fixing our problem.

The privatisation of government utilities such as Telstra has also meant that these utilities have reduced substantially the attention they give to conducting or subcontracting research and development with universities. They are understandably putting more effort into seeking to maintain a market share through better customer service, and lowering cost structures.

Last year I gave evidence to the House of Representatives Standing Committee on Industry, Science and Technology on behalf of the Australian Academy of Science. I argued that the government needs a mechanism to compensate for the loss of utility funding for IT research. The rural research funds could be a model: to reduce the demand on public funds, industry stakeholders contribute.

The problem of corporate under-investment in research and development needs addressing in the most determined way, and not just of course for the IT sector. The 150 per cent tax concession for research and development should be restored, or a variant of it introduced – there are plenty of international models. The Government should also implement the Ralph report proposals to move away from our punitive capital gains tax regime.

Australia will only remain among the advanced countries through the production and exploitation of knowledge. If a company has knowledge, it can make profits. If a nation has knowledge, it can survive and prosper in an information revolution. But we must have a change of public policy settings and private attitudes.

BUILDING THE KNOWLEDGE ECONOMY

The UK Government's White Paper

Our Competitive Future: Building the Knowledge Driven Economy,

released in March 1999, set out a wide-ranging programme to help British businesses match the best in the world.

This programme is aimed at helping the UK reverse a century of relative economic decline. The White Paper called for a renewed focus on knowledge as the means of providing competitive advantage - knowledge in the broadest sense, including the skills, creativity and expertise of all those involved.

The challenge for UK business is to develop and harness these sources of knowledge, skills and creativity in order to raise productivity and increase innovative capacity. The role for Government is to create a business-friendly environment by providing help and support through investing in British capabilities, by catalysing collaboration within regions and between companies, and by providing a regulatory framework which fosters fair and open competition. The White Paper advanced a large number of commitments by Government in each of these areas. The purpose of this Implementation Plan is to set out in more detail the way those responsible for implementing each of the commitments intend to go about delivering them.

The White Paper's message applies to all businesses, small and large, in manufacturing and services - and in traditional and high tech sectors. Competition is in many ways fiercer and more global for manufactured goods than it is for novel technologies or for services. It is therefore even more important for industries in established sectors to find ways of devising, making, marketing and distributing better products which exceed customer expectations. The White Paper contains many case studies of traditional firms which have found new ways to exploit their knowledge and the skills of their workforce, and to find and serve new customers and markets. The Government intends to give particular emphasis over the coming months to ensuring that the policies and programmes set out in the White Paper are delivered effectively in the manufacturing sector.

This plan is not intended to be a comprehensive statement of everything that will be done to implement the White Paper. That would require a document at least as long as the White Paper itself, since

BUILDING THE KNOWLEDGE ECONOMY CONTINUED...

implementation will involve long-term work bringing together not just central government but a wide variety of organisations involved in helping business improve. The Plan is intended to provide a roadmap indicating the mechanisms, timescales and targets which those responsible for managing the delivery of the commitments have set. Achievement of the milestones and targets in the Implementation Plan will be challenging - and in many cases dependent on actions by a number of people and organisations outside the Government's direct control. Progress will be monitored and reviewed regularly, and the programme as a whole will be evaluated with the assistance of the Competitiveness Council which the Secretary of State will shortly be appointing.

In keeping with the open approach taken to date, the Implementation Plan lists for each of the commitments the name of an individual, with their telephone number and e-mail address. These individuals may not be solely responsible for delivery of the targets concerned, but they act as leaders and co-ordinators, and will provide a knowledgeable central focus for enquiries.

The Plan mentions some of the organisations which will be involved in making a reality of the White Paper, but, again, it does not seek to provide a comprehensive list. Organisations such as trade associations, Business Link Partnerships, Regional Development Agencies and many others will have a vital role in implementing the White Paper commitments and will be consulted and involved throughout the process. The Government is pleased that Business Link partners have taken the initiative of identifying individuals to lead on each commitment within their own partnership.

The publication of this Implementation Plan demonstrates the Government's determination to carry through the commitments in the Competitiveness White Paper and to work in an open and transparent way. The plan is, however, only the beginning of the process. The real work starts now.

The Implementation Plan is divided into five tabular sections: Building UK Capabilities, Collaborate to Compete, Competitive Modern Markets, Information Communications Technology and Innovation and Entrepreneurship in Government.

THE KNOWLEDGE REVOLUTION – OPPORTUNITY OR THREAT?

The evolution of the Knowledge Industry flows inevitably from the revolution that continues unabated in the Information Technology and Telecommunications (IT & T) industries.

The Gartner Group claims that in 1998 the world spend on IT & T was greater than one trillion US dollars or close to two trillion Australian dollars. Supporting the view of continuing dramatic growth they predict that it will be US$1.7 trillion by 2002 or A$2.8 trillion. The distribution of the spend is heavily skewed to the OECD economies and even then anomalies exist which point to the very strong position Australia currently enjoys in its uptake of IT & T. Although Australia is a small nation in all but geographic size, results of a study commissioned by WITSA (World Information Technology and Service Alliance) and conducted by the IDC Corporation last year, ranked Australia ninth in the world in 1997 in terms of the absolute amount spent on IT & T. It has retained that position since the previous survey in 1992. Hence it remained in the top ten nations over this five year period although the entry of two of the world's largest nations, the Republic of China and Brazil, is indicative of the inevitable pressure which Australia's position will face.

This skewing of the penetration of the IT & T industries raises a number of other issues which are more appropriate to a discussion of societal and political impacts which will differentiate the knowledge rich nations from the knowledge and even information poor ones. This phenomenon is likely to exacerbate the already tremendous divide which exists between the financially wealthy and the poor nations. Statistics from the WITSA study which compare the number of telephone lines per household, the number of Internet connections per head of population and the number of PCs in schools, demonstrate a huge disparity.

The impact of the IT & T revolution is widespread across society. In this paper, I will concentrate on the business aspects and specifically on the business to business interactions, which is where it is emerging most rapidly. There is little doubt that its impact will be equally profound on consumer behaviour but the emergence is slower for a number of reasons. These include access to the Internet, the availability of an easy to use PC and security and privacy concerns. Generally speaking, these issues are either non-existent in the business environment or they have been resolved.

There are a number of key drivers of the inexorable dependence of business on IT & T.

a) Historically, business executives saw IT & T as the provider of the technology required to enable the business to perform current business processes faster and cheaper. IT & T professionals were viewed as technologists who were not connected to the overall business objectives. It was rare for Chief Information Officers to be members of executive management teams and even more rare for them to sit on Boards of Directors. Today, successful business leaders recognise that it is the integration of knowledge enabled business processes into the business operations which will ensure competitiveness and ultimately survival. It is interesting to note that of the top one hundred companies listed on the New York Stock Exchange at the beginning of the century only one still enjoys that position today. The rate of change accompanying the information revolution is orders of magnitude greater than that which existed early in the twentieth century. Hence it is a reasonable hypothesis that only those companies which truly embrace the information age will retain their position in the new millennium.

   The challenge which confronts business and the IT & T industry is to find a reliable way to align the business and IT & T. This will require the systematic education of business executives so that they understand the potential that the information economy offers and they are equipped to conceive and execute the business strategies necessary to survive and prosper. It also requires IT & T professionals to become more closely aligned to the business objectives.

b) Yesterday the technology itself was expensive; today it is raining cheap technology (the infamous "millennium bug" would never have occurred if the price performance of technology in the 70s and 80s had been at the level it is today).

   However, this does not mean that the implementation of modern systems is inexpensive. Systems are increasing in sophistication and they are penetrating deeply into a business process or processes. There is increasing recognition that, if the organisation is to achieve the benefits for which the system is being installed, then there needs to be strong ownership of the system by the business both during implementation and subsequently. Hence while technology costs are now significantly lower than previously, the labour costs for both IT & T professionals and user staff are typically very significant. Boards of Directors and executive management are demanding that there is a real return on their system investments and that the return is measurable and is measured. Historically, while business cases were demanded to justify an IT & T investment it was rare that any rigour was applied to the measurement of actual achievement.

c) The need to remain competitive in an increasingly global market is fundamental to survival. The emergence of new businesses with totally new cost structures and distribution channels is causing existing businesses to reassess their business models, go to market strategies and processes.

   There are some classic examples of this: Amazon.com is probably the best known and its impact on the book distribution business has been dramatic. However, the much more subtle development from the Amazon.com model is the customer information which they have captured on every person who logs onto their Internet site. This information moves them from generic sales campaigns aimed at many customers to focussed campaigns aimed at individual customers. It also positions them to enter new lines of business with a large well-qualified customer database already in existence.

   The less visible emergence of the on-line supermarket which enables a shopper to sit at home and walk the aisles of a virtual store selecting their groceries, introduces an entirely new cost structure to an industry which lives with low margins today. At the same time it spawns a totally new and potentially huge market for the transport industry which provides home deliveries for the on-line supermarkets. Another by-product is the ability of the business to develop a hitherto unknown profile of each individual shopper's buying preferences and habits.

   Dell Computers in the United States offers customers the option of configuring and ordering their PCs from Dell's web site and guarantees delivery within 24 hours. This is yet another new distribution model that provides significantly different cost structures and service levels to the traditional distributor model. This has forced Dell's competitors to review their distribution systems putting considerable pressure on the traditional PC distributor businesses.

   Gartner notes that worldwide there are relatively few Internet sites that are business enabled and I would suggest that that is certainly the case in Australia. In a recent study commissioned by the Australian Coalition of Service Industries, the chairman, Don Mercer expressed his concern at the apparent lack of awareness by Australian business executives of the likely impact of electronic commerce on their competitiveness and possibly survival.

The Opportunity for Australia

The knowledge industry is significantly different to most sectors where Australia has chosen to compete in the past – there is no material product. The tyrannies of distance from the world's markets do not exist as the information age uses a digital highway. Significantly we are already world class participants in the IT & T industries and possess a first class education system which consistently turns out highly qualified and innovative professionals across a range of applicable disciplines. We have never been better positioned to perform beyond our weight by leveraging our current position to be a significant player both as a creator and a user of the products of the information age.

Not surprisingly there are a number of challenges which we will need to address if we are to realise the potential that exists:

a) The availability of cost competitive telecommunications bandwidth.

b) The provision of a conducive regulatory environment including the establishment of a

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vigorous venture capital market and the removal of capital gains tax from IT & T investments.

c) Our ability to respond to the challenge created by the worldwide shortage of skilled IT & T professionals. Gartner claims that there are currently only 8 people for every 10 jobs around the world.

d) The ability of business leaders to acquire knowledge of the opportunities the information economy offers Australian business and the risks which exist if they do not respond.

Addressing these challenges will require business, government and education leaders to be creative and proactive. They will need to accept that new paradigms may be necessary if we are to succeed in a global market. Most developed and developing economies have government sponsored and supported strategies to capitalise on the opportunities which this exciting industry offers. Ireland, India, Taiwan and Singapore are but a few who have executed very different but successful strategies, which have leveraged their specific strengths.

All Australian governments now have ministries with specific responsibility for IT & T and the Information Economy. There is a strong cooperative spirit between government and these industries to capitalise on our strengths. The objective is to make Australia a leader in the application of IT & T and thereby create world competitive businesses and to establish a globally competitive IT & T industry. There is no doubt the opportunity exists – the challenge is ours. Are we up to the challenge?

MR ALAN BAXTER

Managing Director, DMR Consulting Group (Australia) Pty Ltd, and Chairman, Australian Information Industry Association

The Federal Government should plough the $100 billion in proceeds from a fully privatised Telstra into new public sector enterprises aimed at creating a high-tech future for Australia, according to prominent economist Dr Peter Brain.

Outlining a radical new economic policy blueprint in his new book, *Beyond Meltdown: The Global Battle for Sustained Growth*, Dr Brain argues that Australia should combine the best of the current free-market "neo-liberal" policy approach with much more interventionist industry policies adopted in Europe and Asian States such as Taiwan.

He also paints a grim future for the Australian economy over the next few years, predicting that the manufacturing sector will be savaged by 2002 with large-scale job losses and plant closures.

He says the jobless rate will leap to 10 per cent and predicts a "second wave" Asian economic crisis, saying that the region will suffer from a "rolling recession" for the next six to 10 years at cost of around 350,000 jobs in Australia.

Dr Brain is the executive director of the National Institute of Economic and Industry Research and was the first Australian economist to predict the Asian crisis which began in mid-1997.

He says that as part of a new policy approach to encourage innovation and the spread of cutting-edge technology through the economy, the Government should adopt the Taiwanese "corporatist state" model, investing in new public enterprises to research and commercially develop new "knowledge-based" products and technologies. These would be funded, in part, from the privatisation of mature public enterprises such as Telstra.

He argues that the private sector in small, "technologically inferior" countries like Australia did not have the necessary capabilities and expertise to develop these new industries and technologies in a free market, creating the need for Government involvement to encourage innovation and to invest in crucial infrastructure.

Dr Brain singles out emerging technologies such as biotechnology and advanced materials, as well as telecommunications hardware and information technology, as sectors ripe for development.

He said the ongoing crisis in Asia and a downturn the broader world economy would hit Australia hard in the next millennium.

"Thousands and thousands of jobs will be lost in Australian manufacturing in the next few years, even as Asia's economy slowly start to recover," he said. "By 2000 there will be a million Australians unemployed.

"After the Olympics our economy is in for a lengthy period of stagnation, ushered in either by the economy being ground down naturally as the sources of growth naturally weaken or through a full-blown current account crisis with interest rates probably climbing to 8 per cent.

"The world itself is heading for a sequential series of rolling recessions and periods of stagnation across countries and regions."

He said the industries at risk in Australia are paper, motor vehicles, chemicals, fabricated metals, textiles and clothing.

The above article appeared in the Sydney Morning Herald on 16 April 1999.

THE FUTURE OF SCIENTIFIC DISCIPLINES

Science owes much of its success to its ability to split problems up into individual processes that can be studied in detail and in some isolation.

Professor

PETER CULLEN

CRC for Freshwater Ecology, University of Canberra and President, Federation of Australian Science and Technological Societies

We have developed scientific disciplines to enable cluster of scientists to work together. It is these disciplinary clusters that define the dominant paradigm at any time, and provide the quality control processes through peer review. Much of our present knowledge has been generated within this traditional disciplinary structure.

The disciplines are maintained by the structure of the training we provide to new entrants. University departments and scientific societies have developed to maintain this disciplinary structure. In science there is a propensity to splinter knowledge into what are effectively sub-disciplines that seek to isolate and get their own departmental labels and specialist societies. The tribal nature of the peer reviewing process also works to maintain ownership of certain types of knowledge within particular groups.

This traditional structure is readily supported when science is expanding, but is now under threat when Universities in general and science in particular is in a period of contraction. Universities are now lumping various disciplinary departments into larger units.

Some disciplines, with low enrolments, have resources withdrawn and are under real threat. University staff teaching mathematics in mathematics departments has dropped around 20% in the 1995-8 period, and there has been a drop in physics lecturing staff of 16% over the 1994-7 period. These reductions have occurred even though student teaching load appears not to have dropped. It may be that these areas were overstaffed before these cuts, or that the subject teaching has been taken over within other departments in a bid to maintain teaching load in departments that once would have sent service teaching out to a specialised department. It may be that the specialised departments are not meeting the service needs of the primary discipline. I have not seen any analysis of this issue, and I do not know what the long term implications to Australian science will be. I am concerned that individual Vice-Chancellors are reacting to economic pressures and that the system wide impacts may not be appreciated.

New Modes of Generating Knowledge

Many of the larger problems now facing society are not as amenable to solution through disciplinary research, and require the intellectual contributions of several disciplines if progress is to be made.

This new mode of knowledge production builds on the traditional discipline oriented model of research and its normal quality control system of peer review. The emerging model has the following special characteristics (Gibbons et al, 1994).

- Applied – This new mode of research is driven by the need to find useful answers to complicated 'real' problems. The CRC program brings together knowledge users and knowledge producers and emphasises the role of research in addressing practical problems. The old dichotomy of basic and applied research has outlived its usefulness, and it is becoming more widely recognised that excellent research can be done in applied settings, and is in fact required to solve applied problems. Useful outputs are a critical element of the new model.
- Trans-disciplinary – The new model might be thought of as trans-disciplinary rather than just multi-disciplinary. It does not depend on various disciplinary specialists working in disciplinary isolation with the occasional interconnection. It relies on frequent interaction and stimulation across the disciplinary boundary. Partnership and collaboration across disciplinary boundaries is a key feature (Cullen et al, 1999).
- Transient – The new model is often transient as teams are developed to address a particular issue and disbanded at the end of the task. It is not organised in the traditional university structure that assumes an ongoing existence.
- Quality control – Traditional peer review is still central to the new model, but quality is also judged through the usefulness of the research findings. Peer review may cross disciplinary boundaries and include scientists from within relevant industry organisations.
- Leadership – is shared in terms of the substance of the scientific input, with different individuals 'leading' the group at different stages of its development. Process leadership is also valued in its own right, and effective groups do need someone taking the 'facilitation' role.

Making the new Mode Work

We have been developing this new approach to research in the CRC for Freshwater Ecology. This is an area where there are many isolated disciplines operating,

and we are seeking the synergies from interactions and whole system thinking.

The power of a simple, diagramatic conceptual model of the system being investigated must not be underestimated. All researchers have conceptual models, but often do not make them explicit. If these models can be shared and negotiated issues like the meaning of terms, scale, critical drivers and so on are argued and resolved rather than remaining as hidden barriers to communication. This process allows people to challenge their own assumptions and the baggage they bring to any new problems. Robust argument lets people test alternative views, clarify the appropriate scale with which to view the problem and be comfortable in changing their position or assumptions. The project development teams had to make sure that their projects were built on strong conceptual models, and that the key research questions and key management outcomes were explicitly stated.

The process of developing a conceptual model put the model building at centre stage in the research process. The model becomes a simple statement of the collective understanding of how the system works and is in fact the first stage in articulating hypotheses for later testing. The model is not about putting all possible pathways and interactions into a comprehensive overview; it is a synthesis of views about sub-systems brought to the process by disciplinary specialists. It demands that these views be brought together at a common scale. It is a working model that can be further developed as insights grow through the process. The process makes the players' various assumptions obvious, and allows them to be debated.

The implementation of a new mode for research pushed many researchers outside of the traditional approach to research and often beyond the comfort zones of individuals. Generating conceptual models is time intensive, without there being any guarantee of funding, which challenged the priorities of researchers in a busy and competitive environment. Most researchers found the interactions and knowledge generated were worth the costs. Even so, many involved in the process at times felt alienated, misled, uninformed, or otherwise 'bruised'– as their ideas were scrutinised, their comfort zones stretched and their egos challenged – as the intellectual and interpersonal demands of the process placed pressure upon them. Consequently, efficient, transparent and sympathetic process facilitation was essential. Individuals knew they had an avenue of communication at all times and a means of having a 'say' in the process. They were able to trust in the process and go beyond what was comfortable for them.

The new research mode we are developing is less dependent than traditional disciplinary research on a single 'guru' to guide the research. It does require leadership to manage the process and to ensure that an effective team develops, and that all contribute to the team effort. An individual needs to be designated as 'process manager', and held responsible for establishing and providing a framework where all can contribute. The intellectual leadership is shared with different individuals taking leadership at different stages.

On the other hand, some of the researchers stated that this process provided some of the most stimulating and exciting intellectual debates of their professional careers. Once the dialogue moved beyond a simple posturing as to research methods and resources and started to address the issue of what was the critical research question and whether it was answerable given our existing techniques, then high level intellectual activity took place.

"...this process provided some of the most stimulating and exciting intellectual debates of their professional careers..."

Implications for Universities

The new mode will not replace disciplinary science, but will develop alongside it. Scientists will work in both modes during their scientific careers.

The new mode of knowledge generation poses some interesting challenges to Universities in teaching people to work across, and to manage, the intellectual interfaces that we have previously largely treated as solid walls. The traditional approach to interdisciplinary problems is to assemble teams of the relevant disciplines, focus them on the problem, but then let them work largely within their disciplinary isolation.

The new mode requires them to work as a team and interact on a daily basis. They need to become comfortable in sharing their insights and preliminary thoughts on particular issues. They need to become comfortable with the risks this entails. The CSIRO-BHERT program on leadership of R&D teams is a critical contribution to building these skills in Australian science, and it is hoped that the Universities will get around to developing and teaching these skills in science courses. The new mode also provides major challenges to funding bodies (Metzger & Zare, 1999).

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BUILDING AN INNOVATION CULTURE

To paraphrase an old cliche, the only certainty as we move into the knowledge age is that of constant change.

Australia is well advanced in its move to the information economy – by this I mean the embrace of communications and knowledge management based around advances in IT and communications. The content, ultimately, is knowledge and our effectiveness in using this knowledge to social and economic advantage will set the scene for the type of country Australia will be into the future.

The Internet represents the clearest symbol of the move to the information economy. While having its origins in the 60s, it's only in the last few years that it has moved into mainstream activity.

This has lead, and is leading right now, to a wave of developments as the IT industry, educators and other users identify new approaches to maximising benefit from this communications medium. As well as the more publicised commercial applications, these new technologies are being used for broader community and individual benefit, helping community organisations operate more effectively, helping individuals communicate better and gain knowledge.

The strength and sophistication of Australia's information economy is underpinned by a combination of the skills, innovation and global competitiveness in our information technology and telecommunications industry.

The fact that the information economy is a global phenomenon means that Australia must ensure that innovation has the right environment in which to flourish. To move too slowly at this time is to be left far behind our global competitors.

The Australian Information Economy Advisory Council of which I am the Chairman, was established by Senator Alston, the Federal Minister for Communications, Information Technology and the Arts, late last year.

As the key advisory body to the Federal Government on information technology and information economy issues, its members encompass a broad range of industry, business, community and academic interests, and provide a solid sounding board for the Minister and government on policy directions and priorities.

The issue of creating an environment to foster innovation is of crucial concern to the Council, to Minister and to the government. The Council will be giving this issue close attention in its future deliberations.

There are a number of aspects in this area, which I would like to develop.

Australian companies are producing world class technology and competing with the best that the rest of the world has to offer.

The ground is, however, ever shifting under our feet. Today's leading edge companies can in 12 months just as easily be lagging behind the new trendsetters of tomorrow.

The key to maintaining, and indeed increasing, our competitiveness and our attraction for overseas investment depends, I believe, very heavily on our creativity and flair for innovation.

Economic activity is increasingly knowledge-based; gains in productivity and output are dependent on the development and diffusion of technologies; jobs are shifting from low to high skilled workers; and export growth is driven by high technology goods and services.

Innovation at its core is the ability to manage knowledge to gain market advantage through the introduction of new products, processes and management systems.

It is about creating products and markets for knowledge using innovative approaches and utilising the full potential of the scientific and technological knowledge of our universities, research organisations and entrepreneurs.

Entrepreneurship needs to be recognised as a skill that is vitally important in this area. Often innovators have sound technical skills and understanding – which has led to their discovery of particular leading edge application or product, but what can be lacking is their management and entrepreneurial skills to take this innovation and develop it further. This is an area that the Advisory Council will look at and in particular how young people with innovative ideas, often still at school, can be encouraged and developed.

Innovation performance depends not only on how specific firms and universities perform, but on how they interact with one another as elements of an 'innovation system' at local, national and international levels.

The efficiency of an innovation system depends in turn on the framework conditions under which it operates.

Governments have a crucial role to play in building framework conditions that are conducive to innovation and entrepreneurship. At its core, this means ensuring that risk taking – building on technical innovation – is encouraged and rewarded when successful. This preparedness by entrepreneurs to take risks, to attempt to bring new products and services to market, is ultimately what will drive our competitiveness in the knowledge age. The overall taxation regime is of major significance here.

Taxation arrangements in the capital gains area will also have a significant impact on the access of Australia's innovative start-up companies to venture capital. The venture capital market is a global one and capital will migrate to where conditions and returns are more favourable. Australia must ensure its innovators can compete globally for venture capital.

We all recognise the importance of a sound skills base for Australia to advance in the information economy. What are required are not just high level R & D and technical skills for the supply industries – which of course are vitally important - but also a broader

understanding and knowledge – IT literacy - across the community as a whole.

It is important our schools can meet this challenge and there are signs for example, with the provision of computers in schools and support for teachers, that this is occurring. They will need to, as other countries such as the United Kingdom are taking clear action in this area.

At the level of more specific skills, there is evidence of some shortage of skills required by the IT & telecommunications industries, and governments and industry are working with education and training sectors to examine the dimensions of this problem and identify solutions. This issue is important, not just for the operation and effectiveness of these industries, but also as a crucial enabler of innovation.

Favourable framework conditions enable business, both large and small, and research and education bodies, to adopt best practice in innovation and business management. We need to continually benchmark ourselves against the best that the world has to offer. We need to identify models of best practice both locally and internationally, learn from these and endeavour to take those quantum leaps necessary for true innovation.

Building the conditions and culture for innovation and entrepreneurship in the knowledge age is no easy task. There is much to be gained from government, the education sector and industry working together to pool their considerable skills, knowledge and resources. In doing this, I believe we have the ability to achieve some outstanding results that will benefit all Australians.

MR DON MERCER

Chair, Australian Information Economy Advisory Council

Professor

TREVOR COLE

FTSE
University of Sydney and Chairman, Education Committee, Australian Academy of Technological Sciences and Engineering

(PREPARED AT THE REQUEST OF THE ATSE PRESIDENT)

EDUCATING FOR THE NEW ECONOMY*

There are gaps in Australia's education system if it is to develop an educated population relevant to the rapidly changing world economy. Without a broadly based understanding of the urgency of the issues involved, combined with a vision and accompanying strategy, it is hard to see how Australia can sustain, let alone grow, the knowledge intensive services and industries on which standards of living into the next century will undoubtedly rely.

The knowledge intensive industries and the pervasive explosion of communications and information technology have transformed radically world trade, economic theory and the whole basis of wealth and job creation. In almost all developed and developing countries, as well as in world trade, there has been a major shift to manufactured goods and knowledge-intensive services relying increasingly on advanced technologies with their associated knowledge and skills. Those creating this new wealth have not necessarily been from traditionally strong trading nations and rarely involve companies previously strong in minerals, primary products or simple manufactures. That is, this expansion of trade has provided excellent opportunities for new companies, regions and countries to generate wealth through which they can quickly improve and then sustain the quality of life of their peoples.

Australia's traditional reliance on exports of minerals, primary produce and now services are not enough (by a margin of between $2 million and $3 million per HOUR) to cover the cost of interest on foreign debt and Australia's imports of manufactured goods. Thinking positively, one might say that at least Australians manufacture half of all manufactures consumed in Australia. But when looking at types of manufactures, the picture is bleak. Almost half the imports to Australia are vehicles, computer-related and high-value-added machinery representing just those areas of greatest growth and opportunity in the world and where advanced technologies and knowledge form the keys to competitiveness.

Even worse, the fastest growing job category in Australia between 1985 to 1995 was in accommodation, cafes and restaurants which represents the lowest wage categories. Australia seems heading towards a low wage service economy, sustained only by the products of the agrarian and industrial revolutions of previous centuries and with a burgeoning foreign debt. We live beyond our means with powerful implications for the future of our children and grandchildren. That is, will Australia really grasp the cultural, attitudinal and structural issues needed to move beyond its coal mine mentality to an essential focus on excellence in relevant knowledge, on quality education, and on the economic paradigm on which the next century's wealthy countries will be built?

In the knowledge economy of the future the State and Federal education ministries play a central role in the qualities of future Australians. It is the education system which provides the nation's human capital which should have acquired relevant knowledge to the most advanced standards presently available in the world but who should also have developed a motivation and capacity to interpret and use this knowledge to create wealth for the nation.

The core element to Australia's sustained quality of life will be the relevance and quality of the attitudes and skills of those individual people who create opportunities for themselves and their community through initiative, enterprise and use of appropriate technology. And in this new economy, this new world, focused education of the highest quality is the key to advancement. As Castells and Hall put it so clearly in 1994, *Universities are to the information economy what coal mines were to the industrial economy.*

Investment seeks out highly educated and highly skilled populations and is globally mobile. Financial services as much as advanced manufacture cannot survive in the face of a more educated and motivated workforce in another city or another country. At the present time there are some 190,000 vacancies for high technology jobs in the USA alone, mostly for computer-related skills. The boom from the Information Revolution is thirsting for educated and skilled people from anywhere they can be found, be it India, Russia, Sri Lanka or Australia. Not only is the threat of loss to overseas of Australian knowledge services and industry a real one, so is the threat of a drain of Australia's limited supply of world class individuals.

The other changing trend is the shift from security of employment towards the uncertainty of changing employment opportunities and markets. As Professor J Arbuthnott, Principal of the University of Strathclyde in Glasgow put it, *We are all aware of the changing patterns of employment. Universities have a responsibility to prepare their graduates, not just for employment as in the past, but in such a way that they might take more control of their own employment prospects. Increasingly, this must include the possibility of self-employment and, beyond this, business ownership or entrepreneurship.*

This statement was made in Scotland, a country which suffered decimation of its traditional resource and industry base and which has created a new Scotland. The 100 km belt between Glasgow and Edinburgh has, in a decade, become known as Silicon Glen and from a dying economy Scotland now produces:

- over 35% of Europe's PCs
- over 57% of Europe's workstations
- 25% of the world's luxury woollens
- over 50% of Europe's automated banking machines
- 60% of the UK's semiconductor production.

There are now over 2000 oil industry companies, four of the world's top information systems companies and it is where finance and combined business services of Glasgow and Edinburgh make it Europe's most important financial services centre after London.

This is a country where entrepreneurship is now a core component of the primary school curriculum, and a major element in high school and university. It is a country with a clear central vision and strategy implemented through relevant and appropriate activities defined and delivered at the local level. Scotland is a country which has identified as critical factors skill and knowledge, physical business infrastructure, and access to opportunity. And which has applied these in a balanced way to existing businesses, new businesses, inward investment, and to exports. In all of these countries, it is clear that the focus is a strategic one focused on wealth creation.

Or perhaps consider tiny Finland which has recovered from the collapse of the USSR market by an unashamed focus on relevant R&D and the engineering and commercial skills relevant to trade in high-technology products. This is a country transformed from minerals and primary products to the fast growing technology sector by emphasis on quality education linked intimately to application through technology. This is a country in which government-fostered regional programs of support, specialisation and achievement are well defined, accepted and established.

There are critical factors deemed especially important in the dynamics of these 'technopoles':

1 the achievement of scientific and technological pre-eminence

EDUCATING FOR THE NEW ECONOMY* CONTINUED...

2 the development and maintenance of new technologies for emerging industries

3 the attraction of major technology companies and the creation of home grown technology companies

4 the recognition in press, media and community of the importance of knowledge-based industry

5 the presence of professionals - accountants, lawyers, bankers, financiers - who understand the knowledge-based firm, and

6 an adequate pool of entrepreneurs supplying the 'deals' on which all opportunity depends.

This is a demanding list but contains one essential point. It is not sufficient to simply say that Australia needs more research. Australia is swimming in research results which will never find application in wealth creating activity because of failures elsewhere in the commercialisation chain. In his "The Hollow Man", T.S.Eliot refers to a shadow:

Between the idea
And the reality…
Between the conception
And the creation…
Falls the Shadow.

The conclusion must be made that culturally and in raw attitude and knowledge, this shadow represents a major gulf in Australia's capacity to identify opportunity and to create globally-competitive, technology-based goods and services in response. We clearly cannot control the momentum of change in the world. It will be a matter of playing by the rules that are applied against us, and by focusing on the actual reality of Australia as an urban business scene rather than the rural agrarian or industrial scene of the past. At the core of this is a focus on education and cultural change towards a sustainable economic future based on technology-based entrepreneurial initiative.

Government, business, education, industry, commerce and the community cannot be let off the hook. We must all encourage the initiative of individual Australians who struggle to create real wealth for their nation. It will be hard enough as it is simply to catch up on the decades of more rapid development elsewhere.

As to positive initiatives which should be taken, the necessity for rapid change means that any initiative must bypass the deadening hand of existing structures. Initiatives are needed which are separately funded with strong incentive to create change. Assistance to universities is needed to establish centres which are world class in the way they create major impact on the enterprise culture in Australia. Such centres would focus on technology transfer between the rich science and technology base of Australia and those who can make profitable use of that knowledge. They would be the point from which enterprise techniques would be provided into the courses and training of scientists and engineers. They would be the engine for creation of new, high growth companies in the sectors and markets relevant to a twenty-first century Australia.

***Based on a paper written for the ASX Perspective, first quarter 1999.**

WOMEN IN I.T. – AN UNTAPPED RESOURCE

"To bring more women into fields where their skills are necessary, after a lifetime of negative messages, demands remedial action, not just a bland assumption that they have the 'opportunity' and they're just not taking advantage of it." Kate Lance, System Manager at internet service provider Connect [Mitchell 1999 p.79].

Introduction

Less than twenty per cent of the annual intake of students into undergraduate computing courses is female. This situation exists despite recognising it as an emerging global problem more than ten years ago and notwithstanding the effort of universities around the world to identify causes and implement courses of action to rectify the situation. What is even more alarming is that the female enrolment rate is decreasing in spite of a growing abundance of career opportunities. Research has shown that access is the critical point since the performance figures for females who take up the challenge and enrol in computing demonstrate that they are more likely to succeed than their male counterparts.

The scale of the problem and the ramifications for the Australian economy are evident when it is realised that "women now represent almost one half of Australia's workforce" and "comprise over 55 percent of higher educational students in Australia" [BHERT NEWS, March 1999, p. 9].

Such a scale demands that concerted actions from industry, government, society and the professions are necessary to arrest the decline and to encourage women into computing careers. Concerted action is necessary since falling female participation rates continue despite the best efforts of various individuals and university programmes.

The problem is however global with Western societies experiencing declines in female enrolments in IT courses although a number of SE Asian countries are less affected.

Some Statistics

Research into the under-representation of women studying computing began in the early 1980's. A variety of figures substantiate the relatively low participation rates as well as the disturbing downwards trend. QUT statistics for the Faculty of Information Technology and reported to DETYA last year confirming both aspects are shown in the following table. The higher female participation rates in postgraduate courses should be noted as should the proportion of female enrolments in Computer Science/Information Systems which has fallen each year between 1993 and 1998 from 23.67 percent in 1993 to 17.77 percent in 1998.

	1993	1994	**1995**	1996	**1997**	1998
UG	**302**	326	**306**	316	**309**	288
	23.67%	22.24%	**19.77%**	18.97%	**18.32%**	17.77%
PG	**120**	129	**121**	116	**145**	137
	37.27%	37.28%	**32.44%**	30.45%	**35.89%**	36.93%

Student Women's Participation - Faculty of Information Technology, QUT

Experience at other Australian universities indicate female enrolment rates that hover around 20 percent while those of Curtin were reported at 10 - 12 percent [Armarego, 1998].

Similar trends have been reported overseas. In the US for example women are reported as "playing an increasingly insignificant role in computer science programs in colleges and universities" while at the same time female enrolments "are increasing as a percentage of total enrolments in higher education" [Kick and Wells 1993]. In Britain the same theme is repeated with a decline of women into university IT courses from one third to what is now currently 5 percent. There was also a reduction in the number of women entering the British IT industry from 30 percent in 1994 to 24 percent in 1998 [Mitchell 1999]. Figures available for Norway were even worse with the female intake dropping from 13 percent in 1986 to 8 percent in 1996.

Rather than accept that the downward trend in computing is in keeping with a general shift in preferences towards other more 'fashionable' areas of study such as Law or Business, away from the technical/science disciplines, Camp makes the observation that, "while the percentage of bachelor's degrees awarded in Computer Science to women decreased almost every year over the past decade, the corresponding percentages to other science and engineering disciplines increased" [Camp 1997]. The question has to be posed as to why there is such a decline in the participation of women in IT programmes when there is an increase in the numbers of women in higher education.

Contributing Factors

Research findings have identified a number of factors that influence female participation rates in IT related courses of study, for example, "women's limited access is largely constructed outside the higher education system and is not significantly related to characteristics of the course or institution at which the course is offered" [Ryall 1998].

A US study identified a need for inculcating enthusiasm at the high school level but found evidence "that even at that early stage some damage has been done: females may already be turned off to the pursuit of computing studies" [Myers 1992]. Other factors include:

– an inaccurate perception of computing careers,

– stereotyping of traditional attitudes amongst peers, parents, teachers channelling females into 'traditional' careers

– lack of interest, lack of information, lack of pre-requisite skills and knowledge (compared with boys who have been attracted to computer games etc. from young age), low levels of confidence

– incomplete career advice

– lack of encouragement

female students

– perceive computing as a male domain

– are less confident about their own ability

– face difficulties obtaining sufficient and appropriate help

and yet female students in IT courses consistently perform better than their male colleagues.

The IT Skills Shortage

Mitchell raises the question as to whether we need more women in the industry? Her response is affirmative "if for no other reason to help solve one of the biggest dilemmas in the IT industry - the skills shortage." [Mitchell 1999].

Various predictions have been made by a variety of spokespersons on the size of the shortage of IT personnel in Australia. The most widely quoted from Telstra's Gerry Moriarty is a shortfall of 20,000 skilled workers. Prins Ralston, the President of the Australian Computer Society estimates a shortfall around 40,000 which is also supported by AIIA's corporate relations manager Michael Hedley [Bennett 1999].

Computer science graduates receive the 5th highest starting salaries of any graduates, according to the latest Graduate Destination survey and the Graduate Careers Council of Australia. In addition promotion is relatively fast.

Conclusion

Despite our best efforts to redress the low female recruitment levels, the problem is not getting any better. At Universities throughout Australia, programs aimed at creating a positive attitude towards females studying information technology at university have been instituted. Through information sessions and social activities on and off campus, attempts have been made to relay the message that women have an important and rewarding contribution to make via the study of computing. There has also been positive encouragement from role models, women who have been successful in their computing careers, who have been prepared to visit schools and speak to students about the positives and negatives of choosing an information technology based career path.

In many universities, outreach programs have been supplemented by the development of university environments that aim to support female students once they have opted for an information technology course. At Queensland University of Technology, there is an email support group comprising female staff and students (WIFIT). Through this medium, concerns are addressed and support programs and social functions are organised. Various institutions have provided scholarships as incentives for female students and there have been special entry programs aimed at mature aged women.

In spite of the number and variety of programs, the percentage of female students choosing to study information technology is declining in most parts of the world. Exceptions include the Norwegian University of Science and Technology and the University of Central Queensland. Both of these universities boasted enrolments of around 38% (from 8% in the previous year in the Norwegian case) after initiatives were put in place to reverse the trend. Extensive information programs and quotas for women were features of both programs. The quota system in both cited cases involved a compromise on the entry standard required by the women.

The success of the Norwegian scheme must be considered from a cost viewpoint. The program received the financial support of five Norwegian companies and involved the provision of extensive support services including the employment of a part-time project officer and an assistant project officer as well as provision of a separate computer room for female students. All up NOK 1.8 million (approximately A$365,000) was spent.

As far as female representation is concerned we can learn much from the cultures of our increasing international students. In particular the SE Asia region where no significant problems with female participation in IT exist because the culture accepts that women "belong" in this career. Some enrolment statistics from the QUT are provided to illustrate this. (Note that actual enrolment figures are unavailable in some years.)

Can Australia overlook 52 percent of its population? If we recognise the enormity of this problem then it is essential that government, business and universities unite to invest in the promotion of IT careers for women. The readers of this publication hold positions which can positively influence the direction that Australia follows in harnessing an invaluable resource. However if we are serious about tackling the problem then, as the following quotation states, we will need to be aggressive and proactive in arresting the decline.

"If we want a different outcome, we're going to have to do things differently. We're making too little progress doing more of the same thing. The time for evolution has passed its timid revolution" (John White, Dean of Engineering, Georgia Institute of Technology)

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	1993 Attrition	Enrol	1994 Attrition	Attrition	1995 Attrition	Enrol	1996 Enrol	Enrol	1997 Attrition	Enrol
Female	6.1%	82	2.3%	4.5%	3.9%	110	128	133	2.4%	123
		45%				37.7%	32.2%	52%		44%
Male	13.7%	102	12.2%	9.3%	12.7%	182	269	123	9.7%	154
		55%				62.3%	67.8%	48%		56%
Total	10.3%	184	7.0%	7.5%	9.9%	292	397	256	6.5%	277
		100%				100%	100%	100%		100%

Faculty of Information Technology Fee Paying International Students

Associate Professor

ALAN UNDERWOOD

FACS PCP

Ms GLENDA MADDERN

Faculty of Information Technology
Queensland University of Technology

HONEYWELL ISSUES RESEARCH ULTIMATUM

HONEYWELL has threatened to cut back on research and development in Australia if the Federal Government does not restore tax concessions to globally competitive levels.

It is re-evaluating the prospects of future developments, due to the high costs of research and development in Australia compared with neighbouring countries.

"The reduction in R&D concession from 150 per cent to 125 per cent is enough to make this country less competitive for developing product for export," Honeywell Australia director Greg Irving said.

The company spends $10million on local R&D of products designed for export.

Honeywell today launches a locally developed industrial automation system designed for small manufacturing and plant processing. It is expected to reap $5million in export sales and create 20 highly skilled IT jobs.

The latest version of the company's PlantScape software, Vista, is a Windows NT-based solution that allows a manufacturing plant to tightly control production processes and integrate devices from a range of suppliers.

Honeywell's decisions on R&D locations were based on performance and financial returns. Mr Irving said. "Australia is not on par with countries such as Singapore, India and Malaysia, which offers 200 per cent tax concessions on R&D in order to build a knowledge-worker base and be competitive in a global market."

"After overhead costs such as tracking development processes and managing accounts, the 125 per cent offered locally is whittled down to about 7 per cent in tax concessions."

Honeywell had recently set up a facility in Singapore, where the government provided half of the establishment costs plus direct cash incentives, Mr Irving said.

"We'll be spending less on local R&D in the future."

The above article appeared in The Australian on 13 April 1999.

CANADA ALLOCATES $C1.8 BILLION TO KNOWLEDGE ECONOMY

The Canadian government announced investment of $C1.8 billion ($A1.9 billion) for research, technology and online initiatives. The country aims to facilitate the "creation of knowledge, the dissemination and sharing of knowledge and the application of knowledge- its commercialisation" in the government's 1999 budget.

The money will be allocated to research and development, technological innovation and financing for innovative enterprises. The Smart Communities Initiative, will be given $C60 million ($A63.4 million) to establish demonstration projects to promote the effective use of information technology in education and life-long learning, health, government services, business and industry, employment, library and information services, transportation and culture. A further $C60 million will be used to set up a Web-based initiative called GeoConnection, which aims to create a comprehensive and integrated data source on the Internet about Canada's geography, environment, people and resources.

The Government will also expand its Internet-based community access program and SchoolNet by investing $C200 million ($A211.2 million) for a three year expansion program which aims to link the nation's schools to one another and the world.

Source: Centre for International Research on Communication and Information Technologies, International Monitoring Database Monthly Update Report, February 1999

AusIndustry
INDUSTRY RESEARCH AND DEVELOPMENT BOARD

GOVERNMENT SUPPORTS AWARDS

BHERT is delighted to announce the major sponsor of the 1999 Awards is AusIndustry and the Industry Research and Development (IR&D) Board.

The IR&D Board is an independent statutory body whose purpose is to administer specific Federal Government programs in support of industry-based innovation, and to provide advice to government on national industry-based R&D strategies and priorities. Its broad mission is to increase the level and commercial success of industry-based R&D in Australia.

AusIndustry, the Federal Government's program delivery agency, aims to encourage research and development and innovation within Australia.

See the following pages for details on the 1999 Awards.

MAJOR SPONSOR

AusIndustry
INDUSTRY RESEARCH AND DEVELOPMENT BOARD

BHERT is delighted to announce the 1999 Awards for Outstanding Achievement in Collaborative R&D and Awards for Outstanding Achievement in Collaboration in Education and Training

Purpose

A series of prestigious awards to recognise outstanding achievements in collaboration between business and higher education in the fields of R&D, and education and training; with the objective of highlighting at a national level the benefits of such collaboration, and enhancing links between industry and universities.

Eligibility

At least one of the participating organisations nominated for the award must be a member of BHERT.

Each submission must be signed by all participating partners.

At least one of the collaborating organisations must be in business and one in higher education.

Frequency

Awards are made annually and presented at the BHERT Awards dinner in November each year.

Number of Awards

There are two Groups of awards.

One Group comprises two separate categories, (1) R&D, and (2) Education and Training.

In each category, Awards are given for new initiatives, i.e. projects or programs in train for three years or less, and for established initiatives, i.e. projects or programs that have been in train for more than three years. These categories are further divided into projects or programs which involve companies with a turnover of less than $50m per annum, and those with a turnover of more than $50m per annum. This results in eight Awards.

The other Group comprises two Awards:

- Outstanding Achievement in International Collaborative R&D, and
- Outstanding Achievement in Collaborative R&D involving a Cooperative Research Centre.

An application may be submitted for an Award in one or both Groups, provided it meets the appropriate criteria. However, no one application can win more than one Award.

Criteria for Assessment

1 **Innovation** – has the project or program produced new products or services; how innovative is it in its concept or idea, design, delivery or content; what new barriers has it surmounted; what new challenges has it identified?

2 **Strength of Relationship** – (a) what is the extent of involvement of the partners? (b) how has this grown over the life of the project or program? (c) how do the partners work together in a productive partnership? (d) what other spin-offs have there been from the project or program for participating organisations?

3 **Outreach Inclusion** – has the project or program attracted new participants since its inception; has it become a model for other projects or programs?

4 **National Benefits** – these may be economic, financial, social, educational or community benefits: may include for example, growth in exports, creation of new jobs and so on.

5 **Cultural Impact** – what impact has the project or program had on the cultures of the participating organisations? What changes have occurred in what is done and the way it is done in the participating organisations; what changes have there been in attitudes, behaviour or values in the participants?

PLEASE DESCRIBE HOW THE PROJECT OR PROGRAM PERFORMS ON EACH OF THE FIVE CRITERIA (ONE PAGE FOR EACH CRITERION)

Process

1 Applications for 1999 are now being sought from all members of BHERT.

2 Deadline for applications is **31 July 1999**.

3 Judging panel is:
Professor Leon Mann, Pratt Family Chair in Leadership & Decision-Making, Melbourne Business School (Chairman)
Dr Bob Frater, AO, Deputy Chief Executive, CSIRO
Mr Peter Laver, Chairman, Ceramic Fuel Cells Limited
Dr Jane Munro, Principal & CEO, Firbank Grammar School
Professor Vicki Sara, Chair, Australian Research Council
Dr Peter Scaife, Director, Centre for Sustainable Technology, University of Newcastle
Ms Moira Scollay, Chief Executive Officer, Australian National Training Authority

4 Evaluations will be completed by **30 September 1999.**

5 Awards will be presented at the BHERT Awards Dinner on 18 November 1999 in Sydney.

6 Submissions to be no more than one page on each of the above criteria.

7 Completed submissions to be sent to the Business/Higher Education Round Table at the following address:
L 5, 1 Spring Street Melbourne Vic 3000
Ph: 03 9654 8824 Fax: 03 9654 8835
Email: bhert@ozemail.com.au

APPLICATION FORMS CAN BE OBTAINED BY CONTACTING THE SECRETARIAT.

LEADERSHIP IN INNOVATION COURSE

One of the most exciting initiatives BHERT is involved in is the unique Leadership in Innovation program.

The program is an intensive three-module live-in training course for prospective R&D managers developed by the CSIRO and the Business/Higher Education Round Table (a forum of business leaders and university vice-chancellors) with significant input into the program from BHP, F H Faulding, and the University of Melbourne.

The Achievement Through Teams - Leadership in Innovation program involves three residential periods of five days duration (commencing on a Sunday afternoon and finishing Friday lunch time). Module 1 is about Self-Management: Module 2, Team Building and Module 3, Organisation Culture and the Future of R&D.

The residential courses are held at small, quality conference centres close to capital cities.

The course design is specific to the needs of R&D technical project leaders; brings together participants from across organisations and functions; encourages integration of professional behaviour with personal goals; and encourages leadership through trust, respect for others and generating enthusiasm for a project.

The program is highly responsive to individual and group needs and provides an environment where participants form a strong learning community and ongoing networks.

The cost of the course is $10,000, which includes accommodation and meals, all training, course materials and coaching between modules.

Dates for Achievement Through Teams Courses for 1999 are as follows:

ATT 9

Module 1	4 - 9 July 1999
Module 2	8 - 13 August 1999
Module 3	12 - 17 September 1999

ATT 10

Module 1	26 September - 1 October 1999
Module 2	31 October - 5 November 1999
Module 3	5- 10 December 1999

Information: Margaret Redford, Ph: 02 6276 6265 or email: Margaret.Redford@lctd.csiro.au

Distinguished Speaker Series

In 1998 BHERT decided to introduce a Distinguished Speaker series of addresses each year featuring eminent "thought leaders" speaking on topics of interest to both the business community and academe.

Distinguished Speakers for 1999 are:

Professor Peter Doherty, AC, will deliver a luncheon address entitled, "*Entering the first science-based millennium*" on Friday, 6 August in Melbourne at the Hotel Sofitel.

Professor Doherty, AC, BVSc, MVSc, PhD, FAA, FRS is Chairman of the Dept of Immunology at St Jude Children's Research Hospital in Memphis, Tennessee. He is a winner of the Nobel Prize for Medicine (1996) and was Australian of the Year in 1997.

Dr Raymond Ch'ien, CBE, JP, will deliver a luncheon address on Friday, 17 September in Sydney, at the Hotel Inter.Continental.

Dr Ch'ien, CBE, JP, is Chairman of Inchcape Pacific Limited and Director of Inchcape plc (Hong Kong). Inchcape Pacific Limited, a US$1billion plus subsidiary of Inchcape plc, is a diversified distribution company active in the automotive, industrial products, branded consumer products, office equipment and logistics services sectors of the Greater China market. Dr Ch'ien provides strategic guidance to Inchcape businesses in the region.

In addition, he is Chairman of HSBC Private Equity Management Limited, an indirectly-held subsidiary of HSBC Holdings plc, with approximately US$1billion under management. He is on the Boards of HSBC Holdings plc and The Hong Kong and Shanghai Banking Corporation. He is the Founder and Co-Chairman of Beijing CAST Information System Technology Co. – a company developing and marketing social security information management systems in the People's Republic of China and a Director of China Internet Corporation Limited, an internet content development company.

Dr Ch'ien also has a broad range of public service responsibilities. He is a member of the first Executive Council of the Hong Kong Special Administrative Region of the People's Republic of China. Additionally, he serves as Chairman of the Industry & Technology Development Council, the territory's highest consultative body on industrial development policy; the Hong Kong Industrial Technology Centre Corporation, which among things, incubates new technology based start-ups; and the Hong Kong / Japan Business Co-operation Committee. He is also a Board member of the Mass Transit Railway Corporation.

Dr Ch'ien is also the Honorary President and past Chairman of the Federation of Hong Kong Industries and serves on the Council of the Hong Kong University of Science and Technology. In mainland China, he is a Board member of the China Center for Economic Research at Peking University, honorary adviser to the China Aerospace Corporation, and honorary professor at Nanjing University. He also holds non executive directorships on the Boards of Kader Holdings Company Limited, a leading toy and consumer electronic products manufacturer; Hsin Chong Construction Group Ltd;, and Tianjin Development Holdings Limited; all based in Hong Kong.

Before taking office at Inchcape, he was Group Managing Director of the Lam Soon Hong Kong Group. It is a US$500 million foods, detergents, beverage cans and electronic products based enterprise with production facilities.

His previous experience has extended to working with an international management consulting firm specialising in executive search, and his first engagement upon leaving the University of Pennsylvania in 1978 with a Ph.D in Economics, was with the Chase Manhattan Bank as Regional Economist.

Members are asked to note these dates in their diaries. Further information on all functions will be given in due course.

NEW BOARD MEMBER

BHERT is delighted to announce that
Dr Mark Toner, Chief Executive Officer, Kvaerner Process (Australia) Pty Ltd,
has agreed to join the Board of Directors.

After graduating in chemical engineering from the University of Melbourne, he carried out biochemical engineering research in the Department of Chemical Engineering at Monash University. He then spent two years in the Department of Chemical Engineering at Imperial College, London, designing a microprocessor-based automatic image analysis system.

After three years working in computer aided design of process plants with General Electric in Australia, he joined Davy John Brown in 1981, becoming Director, Petroleum & Chemicals in 1988. Following two and a half years with John Brown Engineers & Constructors in the UK, he returned to Australia in early 1995 as Managing Director of John Brown's Australian operation. The company was bought by the Anglo-Norwegian engineering and construction group, Kvaerner, in 1996.

BHERT welcomes Dr Toner to the Board and looks forward to a very productive association.

BHERT Policy Statements

As a unique group of leaders in Australian business and higher education, the Business/Higher Education Round Table (BHERT) sees as part of its responsibility the need to articulate its views on matters of importance germane to its Mission. In recent times it has issued three Policy Statements – copies of which are available from the BHERT Secretariat.

Position Paper No. 1 (July 1998) – Higher Education in Australia: The Global Imperative

The Business/Higher Education Round Table (BHERT) comprises the chief executives of many of Australia's major corporations and the vice-chancellors of Australia's universities, with the mission of advancing the goals and improving the performance of both business and higher education for the benefit of Australian society.

Education and training is a key ingredient in growing and developing the Australian economy. The industries of tomorrow are going to be increasingly knowledge-based. Higher education therefore is critical to the future of this country; in creating a "learning society" in which all Australians, of whatever social, cultural and economic background, have access to a post-secondary education of excellent value.

Without a national vision and sufficient investment in our higher education system, Australia and today's young Australians are likely to be marginalised as the region moves towards higher welfare standards and more advanced social and political structures. Our goal is that Australia must develop the expertise of its human resources so that it is a significant regional leader in professional, service, education and technological fields.

In today's environment there is a certain tension which universities and their staff feel in attempting to maintain the traditions of high quality research, scholarship and teaching.

Increasingly, reducing resources, coupled with a greater emphasis on revenue raising and entrepreneurial activities as well as inter-institutional competition, both domestic and international, have led universities and their staff to question their capacity to maintain the quality of the learning experience that they provide and the values of the research they undertake.

BHERT has identified the necessary key features of the higher education sector in this country - the prerequisites for Australian universities to compete effectively at the highest international levels.

Position Paper No. 2 (October 1998) – The Development of Cooperative Research Centres

CRCs were established in Australia in 1991 to foster ties between universities, industry and government departments and research organisations, in order to bring research closer to commercial realities and provide education and training opportunities. The program was established to address a number of specific issues, among which were:

1 The need to ensure that advances in science and technology were linked to applications in various sectors of the economy.

2 Related to this was the need to improve international competitiveness. The need to ensure that Australia's undergraduate and graduate programs in science and technology were of world class; specifically involving researchers from outside the higher education sector to ensure better quality and performance.

The CRC Program was to play an important role in ensuring that Australia benefited from the strength of its science and technology resources. Specifically, it would help ensure that Australian research and research training remained at the forefront in those areas of specific importance to the country as a whole.

There are 67 Centres currently operating in six industrial areas:

- manufacturing technology;
- information and communication technology;
- mining and energy;
- agriculture and rural based manufacturing;
- environment; and
- medical science and technology.

Overall the program has resulted in a strongly positive effect on Australian spending on research and development by government departments, universities, CSIRO and other public R&D agencies and industry.

Continued...

BHERT Policy Statements

Position Paper No. 3 (April 1999) – The Case for Additional Investment in Basic Research in Australia

In the latter half of this decade many OECD governments, including the US, Japan, Germany, UK and Canada, have recognised public investment in basic research as essential for economic development. Emerging Asian economies, despite the setbacks of the recent financial crisis, are maintaining growth in public investment in R&D including basic research. All these countries have provided additional funding for basic research despite competing budget priorities.

Much of the economic growth in this decade is attributable to the growth of knowledge based industries particularly those associated with information technology and biotechnology.

Returns on investment in basic research over the next decade are expected to be even greater than in the 1990s. Completion of the sequencing of the human genome scheduled for 2003, for example, will provide unprecedented opportunities for growth in biotechnology industries for countries able and willing to position themselves. Australia is one of only eight to ten countries that have this capability. Continuing rapid advances in information and communications technologies provide immense opportunities for nations prepared to exploit them.

As in the case of the UK, where substantial funding increases for research were provided within the context of a Competitiveness White Paper, Australia needs to ensure that additional funding is provided within a broader policy framework. Such a framework should ensure maximum returns from this investment through diffusion of knowledge to industry and community, improving the skills level of the workforce, encouraging organisational culture change and collaboration, and promoting competition.

The purpose of the Business/Higher Education Round Table (BHERT) is to pursue jointly initiatives that will advance the goals and improve the performance of both business and higher education for the benefit of Australian society.

It is a forum where leaders of Australia's business, research and academic communities can jointly examine important issues of mutual interest, to improve the interaction between Australian business and higher education institutions, and to guide the future directions of higher education.

Mission Statement

In pursuing this mission BHERT aims to influence public opinion and both government and non-government policy on selected issues of importance.

BHERT believes that a prerequisite for a more prosperous and equitable society in Australia is a more highly-educated community. In material terms it fosters economic growth and improved living standards - through improved productivity and competitiveness with other countries. In terms of equity, individual Australians should have the opportunity to realise their full social, cultural, political and economic potential.

The membership of BHERT comprises, by invitation, the chief executives of major Australian corporations and research organisations, and the vice-chancellors of Australian universities.

BHERT pursues a number of activities through its Working Groups, State Chapters and active alliances with relevant organisations both domestically and internationally. It publishes a regular newsletter (BHERT NEWS), reporting on its activities and current issues of concern relevant to its Mission.

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MEMBERS OF THE BOARD

PLEASE NOTE THE FOLLOWING DATES FOR 1999 BHERT MEETINGS:

Thursday, 15 July 1999

Melbourne – Sheraton Towers Southgate – 4pm - 7pm

(followed by dinner at which His Excellency Mr Aneurin Hughes, Head of Delegation of the European Commission, will be the after-dinner speaker)

Thursday, 18 November 1999

Sydney – Hotel Inter-Continental – 2.30pm - 5pm

inclusive of Annual General Meeting (followed by Awards dinner at which Senator the Hon Nick Minchin, Federal Minister for Industry, Science and Resources, will present the Awards and deliver the after-dinner address).