BUSINESS/HIGHER EDUCATION ROUND TABLE

BHERT NEWS

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PRESIDENT'S MESSAGE

Our capacity to innovate, to develop new products and improved methods of production, is an important driver of economic growth and overall well-being.

In Australia, we have a mixed record in innovation. There have been some spectacular successes in basic research, and in applying and commercialising research. However, the amount we spend on our 'innovation system", including our higher education pure and applied research activities, our government research bodies and R&D within business, remains low by international standards.

Developing our 'innovation culture' requires a co-operative effort between business, government and higher education. Government support through research and development tax concessions and other funding plays an important role in promoting business innovation. Co-operation between business and higher education is also a necessary ingredient and BHERT is continuing to seek ways of promoting this relationship. Programs such as the BHERT leadership program for CRC's are just one example of the scope for co-operation to support an innovation culture.

Dr Roland Williams (President), Chairman and Chief Executive, Shell Australia Limited

STRONG INNOVATION... THAT'S WHAT AUSTRALIA NEEDS RIGHT NOW.

"They that will not apply new remedies must expect new evils; for time is the greatest innovator." When Francis Bacon wrote this some 370 years ago I am quite sure he did not foresee the importance innovation would play in today's economies.

Australia needs a much stronger and vigorous innovation culture. We have a proud history of creating new inventions and the list is quite long of new ideas that have emerged from our nation. However, on the other hand our record is quite appalling in our failure to turn those bright ideas into commercial reality. Too often this has been done offshore, and we have lost the benefits of the economic growth that flows from commercialisation.

What underpins the resilience of the American economy? Is it investment? Is it a large domestic market? What is the engine for growth?

In large part it is innovation and entrepreneurship - both of which drive constant regeneration of industry. With a strong base of investment and venture capital, entrepreneurs are constantly erecting new industries and products to supplant those in decline. Constant innovation is one of the great driving forces of the US economy.

Some months ago the Presidents of Australia's two science and technology academies (Australian Academy of Science and the Australian Academy of Technological Sciences and Engineering) were so disturbed by a recent survey comparing Australian companies' policies on innovation to those of their counterparts overseas that they issued a joint statement saying that they were dismayed and concerned at the low priority the leaders of Australian companies appear to place on innovation.

They went on to say, "These disturbing findings should sound alarm bells in this country. We believe the federal government in particular should pay urgent attention to them."

Dr. Terry Cutler, then Acting Chairman of the Industry Research and Development Board, was quoted earlier this year as saying that not enough Australian companies are performing R&D and those that are do not do enough for it to have an impact on their global competitiveness. He estimated that about 1% of the population of Australian businesses are using R&D incentive programs. He said the number spending more than 5% of their turnover on R&D was "minuscule".

Executive Director: Professor Ashley Goldsworthy AO, OBE, FTSE, FCIE

Furthermore he said the support is going to traditional, old-style manufacturing industries, and not the new high-growth IT&T industries which Australia needs to boost.

The recent Business Council of Australia survey (which has not been released) is reported to show a 3% decline in industry spending on R&D in

...Japanese organisations spend about three times more on R&D than their Australian counterparts...

1996/97, an estimated decline of 5% in 1997/98. This represents a reduction of more than $1.5 billion or about a third over the growth which would otherwise have occurred in R&D expenditure. Survey respondents also expected R&D to fall by 23% in the current year although surveys of this kind tend to overstate future 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. It

EDITORIAL CONTINUED..

also suggests that undermining policy continuity has great costs. Businesses were beginning to invest with confidence that the R&D tax concession was here to stay. Now they are reluctant to rely on even the small amount of assistance that remains.

Dr. Malcolm McIntosh, Chief Executive of CSIRO, said the report showed that the amount of R&D being done in Australia is slowing down; and this is undermining the competitiveness of Australian industry.

Norman Barter, the Executive Officer of the Food Industry Council of Australia, said that we will have to buy innovation from overseas and, 'What is happening to R&D spending is disastrous."

Professor Vicki Sara, head of the Australian Research Council, has suggested that the ARC is supporting fewer research initiatives than it has ever done. She made the point that if basic research gets ignored, pretty soon the economy runs out of ideas.

Some analysts believe that the technology boom in the US is being stimulated by public not private funding. The National Science Foundation recently found that 73% of all patent applications in the US originate in publicly funded institutions and that fewer than one in five come from industry.

In Australia, it is specifically in the business sector that expenditure on R&D is a problem. Gross expenditure on R&D in Australia as a percentage of GDP is around 1.6%, a respectable figure that is close to the OECD average of 1.94%. But public expenditure in Australia on R&D is 0.84% of GDP, significantly higher than the OECD average of 0.71%. By contrast, business expenditure on R&D is only 0.8% compared with the OECD average of 1.19%. This puts us about 16 out of 19 OECD nations in terms of business expenditure on R&D.

By way of contrast Japanese organisations spend about three times more on R&D than their Australian counterparts.

Sir Gus Nossal, one of Australia's most eminent scientists said, "The downturn in R&D spending revealed in the BCA survey is a tragedy for this country and it is directly attributable to tax changes."

The Australian Bureau of Statistics released in June a survey of innovative activity which showed that the number of companies engaged in such activity fell from 32% in the three years to June 1994 to 26% in the same period to June 1997.

In December, the Federal government announced that five new funds would be offered the opportunity to run an Innovation Investment Fund (IIF) which would specialise in early-stage venture-capital initiatives.

The government seeded the five ventures with $130 million, matching private sector capital on a two-for-one basis. In addition, the government effectively structured the deals so that - once it has got back its original investment plus interest - the private sector's contribution receives a super-charged return. These schemes should be attractive to the large super funds and similar investors.

The Government has also greatly expanded the R&D Start program, providing an extra $556 million over four years, bringing the total program expenditure to $730 million in the period up to June 2002.

There seems to be little doubt that we need to lift our game if we are not going to lose the competitive edge that flows from constant innovation. But it would be wrong to see government alone as the solution. It needs the concerted effort of government, business and R&D practitioners to build a culture of innovation in this country so that we benefit from a vibrant economy fuelled by the commercialisation of our ideas.

UNIVERSITY-Industry Support for Master Degree Course

The Cooperative Research Centre for Advanced Composite Structures (CRC-ACS) is working with its participant universities to offer a Master-with-Industry program, which aims to locate master degree students in industry to undertake a research thesis. The CRC-ACS and the University arrange these attachments, provide access to their resources, and supervise the research projects.

The research topic is based upon an industry research or development need and lasts for about six months. The host company is required to pay the student a modest stipend during the attachment period and has the right to use the intellectual property which is developed.

The program aims to improve industry's appreciation of the importance and benefits of research, and to help students find long-term, career employment.

Any business member who might be interested in participating in this scheme is invited to contact
Dr Gordon Long, Director,
CRC for Advanced Composite Structures,
506 Lorimer Street,
Fishermens Bend Vic 3207.
Ph: 03 9646 6544
Fax: 03 9646 8352.

AWARDS FOR OUTSTANDING ACHIEVEMENT

The Business/Higher Education Round Table is proud to announce a prestigious series of annual Awards which recognise outstanding achievements in collaboration between business and higher education. The objective is to highlight at a national level the benefits of such collaboration, and by so doing to enhance the links between industry and higher education.

The Business/Higher Education Round Table Award for Outstanding Achievement in Collaborative R&D and *The Business/Higher Education Round Table Award for Outstanding Achievement in Collaboration in Education and Training*

One of the key initiatives being pursued by BHERT is the need for more extensive and effective collaboration between industry and higher education in Australia in a number of areas.

Unfortunately, in Australia the links between the two sectors, particularly in research, lag well behind most major industrialised countries. BHERT, with its unique membership, is committed to several initiatives to further develop these linkages. These Awards are part of that endeavour.

We are delighted to advise that the Hon. Jeffrey Kennett, MP, Premier of Victoria has agreed to present the Inaugural BHERT Awards at a dinner on Tuesday, 10 November at the Sheraton Towers Southgate, Melbourne.

The Awards are being sponsored by several of our Members and details of individual awards will be announced when those sponsorships are finalised. Awards will be made in a number of categories. In both R&D and Education/Training, awards will be given for new initiatives, ie projects or programs in train for three years or less, and projects or programs that have been in train for more than three years. These categories will be further divided into projects or programs which involve companies with a turnover less than $50 million per annum, and those with a turnover of more than $50 million per annum. This results in eight Awards in all.

Awards will be made for projects or programs which have produced new products or services. Criteria for assessment will include innovation, strength of relationship between the partners, national benefits, and cultural impact. Only one of the partners in the program or project needs to be a member of BHERT, which widens the field of eligibility considerably.

Applications were sought earlier this year and closed on 31 July 1998. They are currently being judged by a suitably qualified team of judges under the chairmanship of Professor Leon Mann, Pratt Family Professor of Leadership and Decision Making, Melbourne Business School, and include:

Dr Jane Munro, Headmaster, Principal and Chief Executive Officer, Firbank Anglican School for Girls'

Dr Ian Paterson, AM, Headmaster, Knox Grammar School (Sydney)

Professor Vicki Sara, Chairman, Australian Research Council

Dr Peter Scaife, Interim Director, Centre for Metallurgy & Research Processing, BHP Research

BHERT intend that these Awards become a highly respected annual recognition of outstanding achievement in an area of activity vital to the future of this nation.

THE INNOVATION RACE IS ON

Discussions about the state of Australia's economy are frequently based on the assumption that Australia is not as 'successful' as its peer group nations because its industry lacks the size, the innovativeness and the competitiveness typical of the world's leading economies.

We compare our economy with the those of the US, Japan, France, Germany and Sweden, which all have enviable records in producing and exporting high value-added products.

A common perception is that Australians are good at research and invention, but we have a deplorable record in converting new ideas into commercial realities.

Assessing the truth or otherwise of this perception is no simple matter. There are certainly a number of models of small successful nations, such as Taiwan, Israel and Sweden which have created flourishing technology-based industrial cultures. Taiwan is an outstanding example which in less than two decades has revolutionised its exports. In the early sixties, Taiwan was a low-technology subcontractor to the American electronics industry. Now the Taiwanese have a stranglehold on key areas of the computer industry, including screens, keyboards, laptops and printers.

What has driven that transformation?

A blend of opportunity, entrepreneurial drive, US-educated PhD graduates by the shipload, a favourable investment regime and strong internal linkages between the companies producing these products.

Israel presents itself as another model of technological achievement. Driven by natural entrepreneurial talent, a huge influx of highly educated migrants, a technologically demanding defence sector, and massive infusions of US venture capital, the Israeli high-tech sector has mushroomed in the past decade and is now regarded as a world leader in a number of technology areas.

The third model is Sweden which, for its size - a population of nine million - boasts a high number of global companies such as Volvo, Electrolux, Ericssons, and Astra Pharmaceuticals. These powerful, highly innovative multinationals have carried the Swedish economy to remarkable levels of prosperity over the past 50 years.

Three economies, all roughly the same size as Australia, each present a different path of growth leading towards the same outcome - technologically sophisticated economies comprising high value - added producers whose success feeds on itself to create powerful players in the international arena.

How do we measure and judge the Australian economy against these three? Is our performance poorer than theirs? Is our future more constrained than theirs? Do we lack some vital constituents necessary to become a successful 21st century culture?

Obviously, by some objective measures the Australian economy has slipped backwards over the past 20 years. Our exports have grown less strongly than many other OECD countries and the technological intensity of our exports is low by comparison with our OECD peers. Those two issues are related, and due to the fact that the terms of trade have moved steadily against low value products in favour of high value-added products, we have to keep exporting more quantity to make up for the lack of technological quality.

And yet, is it the case that Australia is failing to stay with the leading pack in the technology race?

We have historically been an inventive, research-oriented society, although recent statistics on publication of research have suggested that our performance is slipping by international standards.

If we regard innovation as the focused search for new solutions, then we certainly have strengths - our mining and agricultural sectors, for example, have long been characterised by highly innovative adaptation of technology.

Our wine industry has become a world leader in oenological processes such that we are now exporting our viticulture back to France and many other places around the world.

Our mining industry has made and continues to make clever breakthroughs in the search for solutions. Australian mining software such as that produced by Mincom in Queensland is world-leading, as are the slurry pumps produced by Wormalds.

A small number of other sectors have distinguished themselves on the world scene, such as the high speed aluminium ferry industry, where a handful of clever, innovative companies such as Incat and Austal Ships have snatched a commanding share of the new generation catamaran market.

Our software industry, fragmented and small scale though it is, has many people and products which are of world standard, even if they lack the resources to compete with the global companies such as SAP and Microsoft.

However, over the past 50 years, Australia has tended to lack the critical elements needed to kick start the high technology sector, and Governments have frequently failed to provide conditions that could possibly have created an artificial basis for new technology industries. Many would argue that the Whitlam government's decision to simultaneously dismantle tariff protection and appreciate the value of the dollar kicked a huge hole in the then fledgling microelectronics sector.

We simply did not have the organised intellectual and capital resources - call them multinationals - which could act as the crucible for new technological products. AWA was perhaps the only company with the potential to grow to this level in the 1970s.

Our world-ranking expertise in medical and pharmaceutical research has always been under-utilised here in Australia due to the lack of global-scale companies which could invest the huge amounts required to commercialise new drugs.

The central role of innovation in economic growth only began to be understood in the eighties, when serious thought was given to how to assist companies to develop new products and to access new export markets. The single most important action by Government was arguably the introduction of the 150% R&D Tax Concession in 1985, a move which stimulated an increased investment by the private sector in R&D from a mere 0.26% of GDP to 0.86% of GDP in 1995-96 - although the level remains well below the OECD average of 1.19%.

The decision by the Coalition Government to reduce the tax concession to 125% is seen by many as a serious error which could undermine the progress of the last decade.

But getting the policy settings for innovation right means more than simply providing incentives for research and development. To gain the momentum necessary to keep up with world markets, we need to be part of those world markets. We need to compete for foreign investment funds - a matter in which we have been singularly unsuccessful due to our tax regime - and we need to attract R&D and manufacturing investment by global companies in order to benefit from the knowledge and culture of innovation which they bring.

Clusters of innovation and excellence are the critical incubators of new technology. Building linkages between the academic and business worlds is vital for rapid transfer of ideas. We need to identify sectors where we can get some comparative intellectual advantage and build on those strengths as Taiwanese industry has done.

We need to foster a strong dialogue between entrepreneurs and the providers of capital as has been the experience of Israel to act as a catalyst of change and the growth of wealth.

We have to recognise our own limitations. With some very rare exceptions, it appears unlikely that we will be able to create substantial international companies in the high value added field, notwithstanding the success of companies such as F H Faulldings or Cochlear. Successful though they are, they are dwarfed by their international competitors.

The reality is that once Australian technology companies have demonstrated that they have internationally saleable products, they become susceptible to take-overs from European or American multinationals - there are scores of examples of this over the last ten years.

There are perhaps two qualities deeply etched into our national industrial character that together stifle the successful growth of substantial innovative and export-oriented companies in Australia.

The first is a well-known aversion to risk-taking which is nowhere more pronounced than in our finance and investment sector. As a result, less than 0.1% of funds under management in Australia go into venture capital.

The second quality is the unwillingness of Australian business owners and managers to relinquish a degree of equity and control in order to achieve growth targets of a global scale.

The options for Australia are stark. The consequences of not having an innovative culture are a permanent reliance on low value-added commodities, further contraction of our R&D capabilities and an increasingly unskilled workforce. In the current global economy, that means an inevitable slide in living standards which probably cannot be reversed - ever.

A determined effort will be needed to avoid that option and stay with the leading pack. Innovation is the key.

We cannot afford to sit back and watch our business sector cutting back its expenditure on R&D, as recent figures from the Australian Bureau of Statistics have indicated.

We cannot afford to leave our best and brightest companies to scrabble for growth finance because our tax laws deter the high rollers in the international venture capital game from investing here.

We cannot afford to lose our human resources and intellectual property to other countries because we fail to recognise their potential value.

We cannot afford to undermine the nation's pool of expertise by failing to adequately fund our higher education sector.

Perhaps what is needed is a Team Australia approach which recognises that to compete in the international game we must deliberately marshal our limited intellectual and capital resources and concentrate them in a series of nodes.

The CRC program has been a pioneering - some say brilliant - attempt to forge the elements of the creative process. Not all success is judged in economic terms, and the CRC program cannot be judged either solely in economic terms or yet in terms of its outcomes.

And while Australia's venture capital program is diminutive by world standards, it has contributed over the past seven years to the creation of a cadre of people familiar both with the processes of technology development and with the complex and frustrating task of creating businesses fit and able to live in an international environment.

The real lesson that has to be learnt from the past decade is that we cannot ever relax. The innovation race is on. The competitors are robust, intelligent and motivated and there are no prizes for runners-up - the future belongs to the winners.

R&D LEADERSHIP TRAINING:

Dr Julian Clark
Executive General Manager,
Healthcare Consumer, F.H. Faulding & Co Ltd

Background

One of the biggest issues facing an enterprise is achieving commercialisation outcomes in the face of unpredictable change. Nowhere is this more challenging than in the area of transforming ideas and inventions into fully developed products genuinely valued by the marketplace. Leadership of R&D activities, particularly the development phase, and achievement through teams are critical to the success of an enterprise where many multidisciplinary interactions and complex processes must be orchestrated to achieve the desired outcomes.

F.H. Faulding is a diversified health and personal care company, listed on the Australian Stock Exchange. Faulding's principal businesses are generic oral and injectable pharmaceuticals, consumer health products, the provision of distribution and retail management services to pharmacies and logistics management services to hospitals. Faulding markets its products to and has representation in over 70 countries and employs 3,500 people worldwide.

Sales in 1997/98 were A$1.8 billion and the company currently invests approx. A$ 48 million/year in R&D. Approximately four years ago Faulding recognised that development effectiveness in its Australian technical units must improve and most importantly the R&D units must become intimately linked into the value-adding development process with a seamless transition of activities between development, technology transfer and manufacturing. In parallel with major internal changes to the process of product development options for leadership training were evaluated.

The Investment

The CSIRO-B/HERT R&D Leadership Program was selected to be the vehicle to assist driving change and improvements in Faulding's development processes at Salisbury, SA (oral pharmaceuticals and consumer products) and Mulgrave, VIC (injectable pharmaceuticals). We believed that this program uniquely addressed the weakness in training of scientists with respect to collaborative outcomes and emphasised the understanding of different cultures both within and between organisations. Most important was the course focus on results through experiential training, since we believed that this would produce faster and sustainable improvements.

In total 15 people have attended the course over the last three years - representing 3 different product development units (oral pharmaceuticals, hospital pharmaceuticals and consumer products) and other functions closely involved in commercialisation (project management, quality assurance, manufacturing supply chain management, business development and human resources). In the context of product development and commercialisation, focus on effectiveness and leadership in R&D alone would not produce outcomes if the rest of the organisation was not fully integrated into the one development process (Fig. 1). Furthermore, the development process must be intimately linked to the order fulfillment process to secure effective commercialisation and parallel sharing of limited resources.

People were selected on the basis of their ability to impact outcomes and the initial training focus was on key individuals in R&D and then successively included representatives from other functions essential to commercialisation outcomes from R&D. The intention was to achieve a small but critical mass of leaders who represented the entire development and order fulfillment process. Those individuals likely to be "agents of change" were given priority in selection.

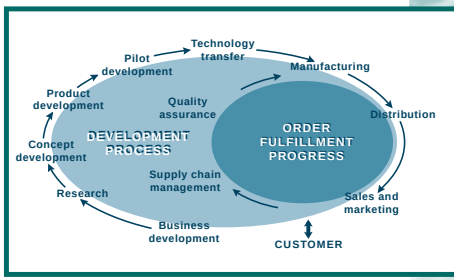


Figure 1: The integration of R&D with the development and other fulfillment processes. Effective R&D must be linked to customer input, supply chain management and quality assurance.

Outcomes

Benefits from this investment in leadership training are clearly evident at both development sites where significant improvements can be seen at the technical and organisational levels directly benefiting the enterprise, and at the personal level benefiting the individuals.

Technical Outcomes

People who attended the CSIRO-B/HERT R&D Leadership course have been directly responsible for driving significant improvements in technical outcomes throughout the development process. In general terms the major areas of benefit have been:

- Significantly reduced project cycle times with faster technical milestone achievement in all three development units
- Less rework and wastage through better planning and experimental design
- Better recognition and utilisation of competence and skills
- Better understanding of technical risk management
- More effective agreement of technical specifications and design-in
- Faster technology transfer, plant commissioning and process validation
- Better project planning and coordination

Organisational Outcomes

Although the initial focus was on improved technical outcomes, an equally important benefit has been the major contribution of course participants in helping to resolve operational issues and implement major strategic and organisational change. This aspect will become more and more important as technical functions are directly exposed to an unpredictable and rapidly changing world. In the last nine months Faulding has implemented a major change in its global organisation to three focussed, fully integrated businesses (Healthcare, Oral Pharmaceuticals and Hospital Pharmaceuticals). The CSIRO-B/HERT course helped participants to anticipate and implement the necessary changes throughout all functions involved in the development process, not just R&D.

As a consequence of the course, all participants have succeeded in fulfilling their respective roles as "agents of change" and skills developed on the course have made significant contributions to:

- Faster resolution of conflicts, both within and between functions
- Speedier and more rational decision making
- Better functioning of multidisciplinary teams
- Improved management of priorities and scarce resources
- Rapid implementation of an organisation change from a functional to a strategic business unit structure
- Greater focus on customer/supplier relationships
- Improved management of redundancies and site relocations

Although the changes could have been implemented without experience of the CSIRO-B/HERT Leadership course there is general consensus that the course enabled faster and higher quality of implementation considering the traditional lack of training of scientific and technical personnel in change management and leadership.

Financial Outcomes

Although difficult to quantify directly, the financial return from investment in this course is significant and is directly related to faster realisation of commercial project value, greater ability to secure effective management of change, and the opportunity cost of time.

The team of trained participants has helped reduce total development and technology transfer times by 25 - 30%. The value of this reduction will vary depending on type of project and has a direct positive impact on cash flow and returns. Furthermore, shorter time-to-market often means faster regulatory approvals, the opportunity to surprise competitors and increase market share, and an ability to quickly move on to the next project.

Participants played a major part in securing a manufacturing plant and development unit relocation ahead of time. This was achieved to budget and during a period of major strategic realignment and other organisational change. Financial benefits are seen through the contribution of the enhanced leadership skills to risk management.

A significant increase in the number of parallel activities has been achieved with a greater number of projects and product introductions being handled simultaneously. This reflects internal efficiencies through less time wasted due to greater inter-functional integration and a stronger ability to stop under-performing projects. Financially this impact is seen as greater return for invested time and money.

In terms of extrapolating this experience to other organisations a minimum return of 10-times the training investment can be realised in the first year provided that a critical mass of leaders from the relevant functions has been trained.

Personal Outcomes

Due to its experiential approach the course has had a lasting and positive impact on all participants. Without exception all participants realised significant personal outcomes from the course - both in their professional and private lives. The most significant areas of enlightenment highlighted by participants were:

- More effective communication - especially listening, appropriate expression and the importance of feedback
- Accepting difference and actively resolving conflicts
- Greater self-awareness and understanding of own drives and drivers
- Understanding impact on others and negotiation skills
- Better understanding of role in teams
- Understanding the benefits of "cross-boundary" and "boundaryless" behaviours
- Improved people interaction and collaborative skills
- Acceptance of and learning from criticism
- Understanding the "bigger picture"
- Improved self-confidence and self-esteem with respect to self-awareness, impact on others, priorities and collaboration skills enhancement.

Many participants also experienced significant benefits to their private lives.

from the areas above.
As a consequence of these personal outcomes, an important benefit from the investment in the B/HERT Leadership course has been enterprise improvements as well as increased motivation, commitment and performance of key people in the organisation. The drive and new skills being used by course participants in having a positive impact throughout the respective organisations.

Summary

The CSIRO-B/HERT Leadership course provides a significant and important resource for the improvement of outcomes from Australian R&D and collaboration. In the context of the enterprise, benefits from the course require a significant commitment from management to ensure that a "critical mass" of participants is built up as quickly as possible. A "lone-wolf" participant is unlikely to bring about sustained changes in a large organisation. Furthermore, it is important to include all functions involved in the development process since leadership in R&D alone will not guarantee business success but is a very important contributor to competence development, setting the scene for continuous improvement benchmarks and delivering greater return from investment in R&D activities. Based on this experience the critical mass for training is believed to be approximately 10%of potential leaders from all relevant functions and the return on this investment in training is at least 10-fold within the first year.

INNOVATION - The Australian Perspective

In 1997 Arthur D. Little surveyed a cross section of senior executives from 50 of Australia's top companies as part of a global review of innovation. The survey's focus was to understand the perceptions and best practices in the use of innovation as a source of competitive advantage and business growth.

The global results, which included responses from over 650 senior executives in North America, Europe, Latin America, and Asia Pacific, overwhelmingly supported the premise that innovation is perceived as a much more critical business success factor than it was just five years ago. However, this view does not appear to be shared by the general Australian business community.

The survey's findings suggest that a large fraction of Australia's "biggest and best" companies run the risk of quickly losing ground by not moving forward fast enough to create the ongoing, systemic capability to innovate.

Most companies have now explicitly built their business strategies on revenue and profit growth, created through the capability to innovate throughout the organisation.

Our conclusion is that companies that are able to create this systemic capability to innovate will realise unparalleled competitive advantage in the coming years.

Our concern is that a disproportionate number of Australian companies seem to run a high risk of failing this innovation challenge.

Most of the Australian executives surveyed believe innovation is best focused on process innovation and to a lesser degree on general business innovation. The focus of business and process innovation within Australia is primarily on streamlining existing operations and not on creating new ways of doing business. This is not likely to create the new opportunities needed to fuel sustainable growth.

The Comfort Zone

Overall, Australian executives are operating in a "comfort zone" relative to innovation. The drive to substantially improve the ability to innovate - to drive change and alter the dynamics of an industry - is lacking in Australian companies more than in those elsewhere in the world.

Australian firms have not realised as much economic benefit from innovation as competitors around the world. This should be seen as a real threat and concern for Australian businesses.

Australian executives, unlike those in all other regions and countries surveyed, with the exception of Korea, do not see innovation as a measurable and improvable business process, but rather something that just happens.

Fig. 1 Importance of Innovation Type to Business Success
(1=low : 5=high)

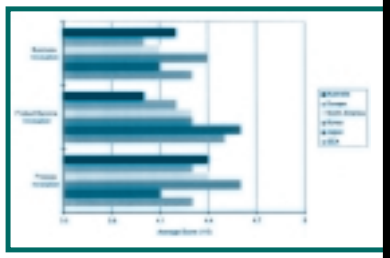
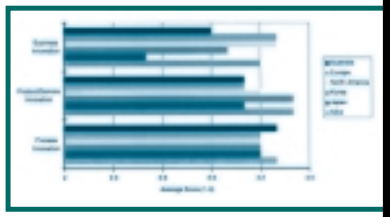
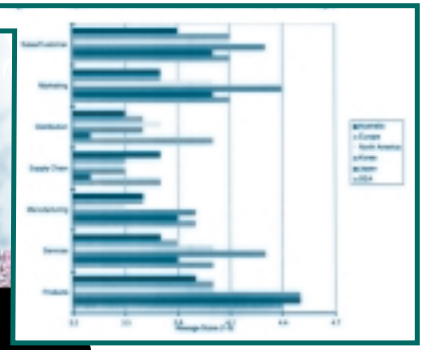


Fig. 2 Current Innovation Performance
(1=poor : 5=excellence)



This "parity" self-rating highlights a potential danger for Australian companies; feeling that they are operating at a world standard relative to innovation but not producing the results.

Fig. 3 Expected Value From Innovation in Next Five Years (1=low : 5=high)

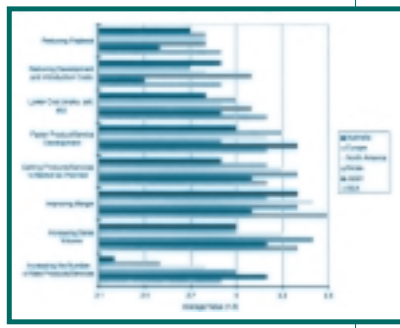


Australian executives fall behind those of almost every country in their expectations of capturing value from innovation. The only exception is that most Australian executives expect to capture more value in the next five years through focusing on supply chain issues than executives in other countries, with the exception of South East Asia.

Unfortunately, those areas of highest absolute importance for Australian companies (new products, services and sales/customer management) are the areas where Australia falls far behind all other regions. With the exception of Europe, Australia falls far behind the rest of the world in looking to marketing innovations as a source of new value.

Australian executives also expect far less value than most other regions in the world from new product and service innovations.

Fig. 4 Product/Service Innovation Importance
(1=low : 5=high)



Compared to their competitors, the focus for Australian companies can be characterised as attempting to generate the highest possible margin on the lowest investment.

Having a few low volume, high margin products is not likely to be the key to lasting success.

Innovation just does not happen. Innovation requires the coordinated focused effort of the entire organisation to create and capture value from the application of new ideas to drive business growth and profitability.

To address the issues of capturing value from innovation, most executives should first "look around the table" and ask what they can do to demonstrate the needed leadership, as well as the required spirit and discipline, to innovate and grow.

(The above article is based on the Arthur D. Little Global Survey on Innovation - The Australian Perspective published earlier this year.)

BUILDING AN INNOVATIVE AUSTRALIA

The matter of innovation is all about building Australia's future. The challenge is to nurture and promote a culture of innovation, a culture of entrepreneurialism, a culture of stretching ambition and high aspirations across our whole community. A culture that says our future is too important to be left to chance. *The challenge we face is how we start to capitalise on Australia's frozen and undervalued assets of intellectual capital, skills, creativity and community values.*

Australia's economic landscape is changing because of the transition from a post-industrial scene of the post-war world to the new information economy of the next millennium. Currently we do not appear to be handling this transition well. Scoreboards and comparative international surveys show:

- low levels of industry research and development
- low rankings for innovation
- limited share of global markets
- limited new enterprise creation and limited commercialisation of innovation

Against this background some industry participants seriously promote a "second best" future for Australia where we:

- provide a food chain of skills and of deal flow for offshore exploitation, particularly within the United States;
- define opportunity and the best use of our entrepreneurial talent as licensing and reselling US technology and operations for the domestic market: a vision of Australia as the Franchisees of cyberspace and the new information economy; and
- host transit points for multinational entry to Asia and become a "staging post" economy.

Other country models show that alternative futures are possible.

The issue is whether Australia too can carve out a distinctive place in the new world. The answer cannot be that we do more of the same - this answer condemns us to those "second best" futures. The answer is how to get ahead of the game.

In getting ahead we need to target both new growth industries and the reconstruction of the old: the restructuring of, and the spin offs from, established firms. In moving from the post industrial to the information economy we need to be conscious that new economic value creation will be knowledge based, increasingly involving intangibles (rather than economic output you can drop on your foot), technology based, transaction based, and governed by new rules for economic value. These are all key parameters of industry innovation to keep in mind.

We need to keep reminding ourselves that most of the dominant firms of the 21st century don't exist today. So we need to break out of the mindset that says that the status quo is the natural state of affairs - for the future. It is not.

The new growth industries we talk about include all the information industries, health services and biotech, education and training entertainment, tourism and lifestyle services, next generation transport, environment management, transaction management services and so on.

These growth industries, and the reinvention of existing industries, are fuelled by innovation and the opportunity for step-function discontinuities in market functions, like the Internet. Comparable discontinuities were created by technologies for fixing longitude which transformed maritime trade, or the shift from the "hardware" of the gold standard to the software world of floating exchange rates.

Innovation has the meaning of new or renewing: changing or altering. The challenge of innovation is relevant to all Australian businesses. The Shorter Oxford Dictionary also reminds us that innovator has an old meaning as a revolutionary. Innovations means changing markets.

To be successful change agents as innovators, we need to have a solid understanding of the emerging market environment, and the discontinuities which can be exploited. The environment for new ventures is the new information economy, and the new environment is complex and multidimensional. To be successful we need to come to grips with innovative definitions or meanings for the basic industry dimensions of time, distance and space, value and relationships.

Focusing on the new pillars for successful innovation means that we can try to create and anchor new wealth within Australia. For centuries Swiss banks used their reputation for trust and confidentiality as an anchor that made them dominant in international finance. What are the anchors that made them dominant in international finance. What are the anchors that will help us hold into the value of our ideas, our intellectual property, into the next century? Let me suggest that there are four dimensions of the new economy that new ventures must come to terms with.

1. The Time Dimension

The Internet symbolises the collapsing of time. We talk about Internet dog years, where old annual cycles reduce to two monthly anniversaries. Yesterday's Internet start up becomes tomorrow's IPO. In an environment where market timeframes have collapsed dramatically, the nature of business planning changes. Fixed strategies carved in stone are out. The new buzz word is how a firm can be "strategically opportunistic." The best formula for business planning is "long term vision and short term tactics = sustainable strategy".

2. The Spatial Dimension (and the geography of new markets)

If time is tricky, then ideas about distance and the geography of markets are even more so. The current economic crisis reminds us that we have a very imperfect international market. Markets may be borderless (they always have been) *but they are not amorphous.*

The most helpful development for a small market like Australia has been the breakdown of Government protectionist models that artificially propped up the unhelpful distinction between domestic and offshore markets. Market geography is not an issue if you operate in a huge market like North America, but for a small remote market like Australia it is crucial. Too many Australian ventures still focus on domestic demand.

The shift is from national monopoly markets to borderless customer markets defined around discrete "communities of interest" and related economies of scope. Global markets do not mean untargeted markets.

The key to the new geography is distributed, networked business operations. The relationship between geographic space and market space is defined by information intensity and interaction: by "psychological space". The old law of being close to the customer.

Thinking about this tricky spatial dimension of new ventures raised the intriguing question of just how we define a company as "Australian" in this new world. Governments and regulators are really struggling here, and their attempts are not necessarily good for the health of Australian ventures. What we simply cannot afford is definitions of national interest that imply that a venture will be penalised if it does business outside Australia!

3. The Dimension of Property and rights

"Who owns what and how". More and more of a company's value is represented by intellectual property, and trade based on intellectual property. Patents, trademarks, trade secrets and copyright are key dimensions to doing business in an information economy.

No small Australian firm can enforce its rights effectively on its own. This is an area where we need collective action, and Government support, to give protection to our big ideas. We need the best possible legal framework. We also need enforcement power. For one example, imagine the difference if the Government empowered an agency like the Industry Research and Development board to become a joint party to the defence of any attacks on an Australian company's patents. Change the playing field.

This growing importance of "information capital" is also affecting the ways we need to think about company structures. Successful growth and its financing means sharing: "share the pain and share the gain". It means sweat equity for staff, partnership models for alliances, and stakeholders power sharing. You need to be ambitious but not short term greedy in the information economy, because if you have the right ideas you can rely on the new economic law of increasing returns to deliver the wealth if you get it right. Just ask Microsoft.

4. The Dimension of Relationships: Business values and ethics

The fourth dimension to being successful in the information economy is the dimension of relationships and business values. In an age of electronic interfaces, in a knowledge-based information economy, the business values and ethics of new ventures will be a powerful determinant of brand value and customer lock-in.

In the 1997 report from the information Policy Advisory Council I described seven pillars for successful market relationships in the information economy, the attributes of:

1. Trust and security
2. Personal control and privacy
3. Authentication and legitimisation
4. Assured recourse
5. Confidence from third party credentialling
6. Labelling and disclosure creating informed choices
7. Reliability

Business systems which support these core values are the key to creating successful partnerships and relationships within an information economy.

Industry and firm competitiveness: covering all the basics

If Australia is to own and exploit its own big ideas, then its new ventures will need to come to grips with these four basic dimensions of the new information economy. But there are also seven key areas where we need collective action to create a friendly environment for innovation:

1. sources of equity finance
2. liquidity in equity markets, to establish the value of ventures
3. analysis and reporting for an informed market
4. people with skills, experience, values and attitudes
5. a supportive legal and regulatory environment
6. vehicles and forums for making connections
7. a community culture of creativity and risk taking

Success requires action on all these fronts and the alignment of all these factor inputs to an innovative Australia. The challenge is simple: either we get smarter, or we accept the inevitability of the "second best" outcomes we have been warned about. If we are to earn a label as innovators, then we have to be change agents.

Dr Terry Cutler is the principal of Cutler & Company. From 1996 to 1998 he chaired the Industry Research and Development Board. He is currently Deputy Chairman of the Advisory Board of the National Office for the Information Economy.

DO WE NEED THE 150%

The Australian Electrical and Electronic Manufacturers Association (AAEMA) urged the government to reinstate the 150% R&D tax concession as part of the fundamental tax reform necessary to encourage investment in Australia's high-technology manufacturing industries.

In a submission to the Taxation Consultative Committee earlier this year they argued that a reduction in support of R&D was one of a number of fiscal disincentives which had impacted on the attractiveness of Australia as a site for value-adding activities.

The Managing Director, Research & Technology Development, of Rio Tinto, Dr. Robin Batterham, in a submission to the enquiry by the House of Representatives Standing Committee on Industry, Science and Technology, 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 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."

A survey by the Business Council of Australia earlier this year is understood to show spending by companies surveyed to have fallen more than 10% since the concession was cut in 1996.

A Taxation Institute of Australia survey found many companies had considered taking their research offshore.

Dr Terry Cutler, then Acting Chairman of the Industry Research and Development Board, said earlier this year that the "symbolic impact of the reduction has been really unfortunate".

Sir Gus Nossal, one of Australia's most eminent scientists said, "The downturn in R&D spending... is a tragedy for this country and is directly attributable to the tax changes."

Mr Charles Allen, Chairman of CSIRO and former Managing Director of Woodside Petroleum, said the cut gave "certain messages... which have not been the sort of message that I think the Government really wanted to get out".

The Minister for Industry, Science and Tourism, Hon. John Moore says the impact of the tax concession cut reflects inflexibility in management thinking. He says the R&D Start grants scheme, introduced in 1996 and expanded twice since then, means the overall policy environment should still be highly attractive. "What we need are some management decisions that are equal to what the policies are," he said. "And if the policies are there in another form, management has to be flexible enough to understand what the program is."

Australian Chamber of Commerce and Industry chief executive Mark Patterson said there was "no doubt there has been a falling off of R&D spending" and "changes to the tax concession have played an important part."

A RESEARCH BROKER FOR THE NEXT MILLENNIUM

by Professor Vicki Sara, Chair, Australian Research Council
Ms Clare White, Counsellor, Australian Research Council
Mr Simon Sedgley, Australian Research Council Secretariat1.

The Australian Research Council's goal is to enhance the national capacity for research to the economic, social and cultural benefit of the community. Our responsibility is to:

* ensure a broad foundation of high quality internationally competitive research; and
* enable its transfer to the players in the national innovation system.

The economic importance of basic research

Research is one of the major drivers of Australia's economic growth and competitiveness in the global market. The success of Australia as a knowledge based economy will depend on our ability not only to innovate - to generate new knowledge, ideas and technologies through research, but also on our ability to broker successful partnerships within the national innovation system and between our system and innovation systems abroad.

Universities are major players in the national innovation system - both in performing research and training skilled personnel. The higher education sector represents 27 per cent of the national R&D effort (Figure 1) and is the provider of research training which underpins the activity of the other 73 per cent of Australia's R&D effort.

Source: Australian Bureau of Statistics, Research and Experimental Development All-Sector Summary, 1996-97

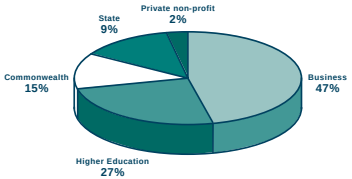


Fig. 1
Expenditure on R&D by Sector, 1996-97

The economic significance of university research is clearly shown through a technique which links patents - as indicators of innovative activity in the economy - to publicly funded research. 397,000 US industrial technology patents were examined. 73 per cent of the patents cite publicly funded research as the source of the new technology. 52 per cent cite university research funded through agencies like the ARC. Industry citations contributed 27 per cent (Figure 2, Narin 1997). The US patent system is representative of the world's technology and the study showed a strong national component in the science-technology linkage.

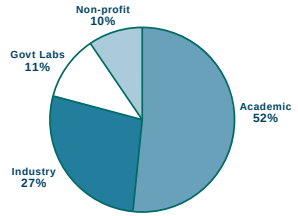


Fig. 2
Source of Scientific Papers Cited in US Industrial Patents

A survey of 63 international studies found annual rates of return on R&D in the order of 20-30 per cent to firms and approximately 50 per cent to society overall. For some specific products rates of return have been particularly high, e.g. in the IT sector, returns have been estimated to exceed 80% between 1987-1991. (National Science Board,1996).

The significance of research has recently been recognised by several countries through increased funding. The US Government has increased research funding to national institutions by approximately 10 per cent, and the Japanese Government by 8 per cent. The UK Government recently announced that 1.1 billion pounds will be invested to improve the science base for

the millennium in a unique partnership with the Welcome Trust, at the same time as additional research is being provided to the Higher Education Funding Council.

Public funding of research in Australia is higher than the OECD average. A large proportion of this is provided by the Commonwealth to the universities. By contrast, industry expenditure on R&D in Australia is lower than the OECD average, and after a period of growth, decreased in 1996-97 by 5 per cent over 1995-96 (ABS, 1998).

University-Industry Interaction

The proportion of research in universities funded by industry has increased steadily since 1984-85, amounting to more than $120 million in 1996-97, a significant increase from $64 million in 1994-95. However, this remains relatively modest at 5 per cent of the total expenditure by universities on R&D (ABS, 1998).

The role of research within the university system is changing. There is a shift away from the notion of grant giving based on excellence alone to one of investment in excellence, which also takes into consideration outcomes and expected returns. Teams of researchers from different areas are needed to converge on a problem to find its solution. Universities are now seeking to develop partnerships within and among universities across disciplinary boundaries and externally with government and non-government organisations, including industry.

The three main mechanisms for managing research and technological cooperation between universities and industry are:

- links developed through contractual arrangements between industrial enterprises and academic institutions or individual academics;
- links that are built around contracts or grants supported through government programmes or other funding agencies; and
- linking mechanisms that create new organisational forms involving both sectors as cooperative partners such as joint ventures or cooperative centres.

The major government programmes which facilitate such interaction are the ARC/DEETYA SPIRT and Key Centres schemes and DIST's CRC and R&D Start schemes. Each has a different but complementary focus and primarily targets different players in the national innovation system. The ARC's SPIRT scheme, for example involves a significant number of small to medium sized enterprises, whereas the CRC programme tends to involve large companies. In the SPIRT scheme APA(I)s are particularly attractive to SMEs with smaller R&D budgets. Through a contribution of only $5000 together with joint supervision of an industry related project, the first step is taken in the development of long term university linkages. A recent survey revealed that SPIRT is the preferred university linkage program of industry due to its greater flexibility (Turpin,1998).

Various studies indicate that industry is generally very positive about research interactions with universities. They indicate satisfaction with the expertise they are able to tap, the value for money from projects, and the opportunity provided to establish more long term relationships with universities. On the other hand, they indicate some reservations about the lack of understanding of industry's commercialisation imperative, the ownership of intellectual property, the need for academics to publish the results of their research work, and differences in organisational culture related to time (Turpin,1998, Grigg,1998).

Brokering the Future

As we approach the 21st century our aim should be to create a seamless web of activity to maximise the flow of knowledge and skills within the national innovation system. Research involves an element of public good and national direction and therefore requires national leadership to enable national goals to be achieved.

The Council sees a need for it to be more proactive in advancing the Australian innovation system by acting as a broker

both nationally and internationally to match the demands of government and industry to the highest quality research in the Australian community. There are two major aims of such brokerage. The first is to act on behalf of the community to provide optimal investment in a broad foundation of high quality internationally competitive research and research training. In general this represents the public good aspects of research. The second aim is to support incentives for private firms to invest directly in research. To achieve this, it is essential to establish mechanisms that allow both suppliers and users to influence decisions about the funding and management of research.

At present, the ARC facilitates direct investment in research and research training by private firms through its various schemes which are described above. In addition, the users of research are involved in decision making about public research funding and management by virtue of appointments of highly qualified individuals from the private sector to the Council and, to a lesser extent, its Committees and Panels.

In any competitive market there is a strong incentive to achieve a balance between supply and demand in as efficient a manner as is possible. In the national and international market for shares, the Australian stock exchange serves an important role in reducing transaction costs by providing a centralised institutional forum in which purchasers and sellers can obtain comprehensive information about market conditions and, on the basis of that information, transact their business.

It is possible to envisage an analogous role for a national research body as a broker in the national and international market for research. Such a 'national research exchange' would have the responsibility to reduce transaction costs and facilitate a balance between the needs of purchasers and providers, both within the national market for research and internationally.

In encouraging stronger links between universities and industry we do not need to (indeed we must not) shift the balance of funding support for university research away from basic research in the direction of applied research. The quality of our basic research and its links to industry is one of our most important national assets for innovation - the success of innovation will depend upon knowledge flows stimulated by such mechanisms as joint industry research, public/private sector partnerships, technology diffusion, shared infrastructure and movement of personnel.

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MANAGING INNOVATION in the 24 hour laboratory

The dynamics of the global economy will continue to drive changes in every function of the firm. This is particularly true of research and development in technology-intensive companies. Georges Haour outlines the challenges of being truly global in managing technical innovation.

There is often confusion about what is meant by the "globalisation of technology". We need to segment this fuzzy concept a little. First, we can see an increasing availability of "technical" products - personal computers, camcorders and so on - wherever in the world they are manufactured.

Second, since the advent of "modern" science and technology as a key ingredient of economic growth (roughly since 1650), there has been a rapidly accelerating increase in the intensity and speed of the diffusion, transfer and exploitation of technical know-how and innovations wherever they are generated.

Third, technology itself, electronic media especially, contributes to enhancing and accelerating the flows of technology around the globe.

Acute worldwide competition between companies, deregulation and substantial reconfiguring of business systems guarantee that turbulent change will continue in companies. The research and development/engineering function in "technology-intensive" companies - those that substantially engage in generating technical know-how on which to build their future - will not escape these developments.

Technology-intensive companies typically include firms in the pharmaceutical, fine chemicals, electronics, telecommunications and process industries. They leverage technology in ways fundamentally different from service companies - banks, airlines, media and entertainment companies and so on - which are users of technology.

For all these companies, the urge to act globally stems from the need to participate in the international flows of goods, capital, information, knowledge and technology. Another motive is the need to compensate for shorter product and service life cycles by making products and services available in broader geographical markets.

Despite all this, for historical reasons and because they are considered strategic to a company's future, most research and development (R&D) activities remain very close to a company's geographic headquarters and are the most centralised of all functions. It is estimated that more than 90 per cent of a typical company's R&D activity is performed in its country of origin.

As an example, Novartis has more than two-thirds of its R&D in Switzerland even though that country represents only 2 per cent of its overall sales. The extreme case is Japan: as little as 3 per cent of its R&D is carried out outside the country.

We know that geographical proximity is a powerful stimulus to interaction across units and functions. The attempt has thus traditionally been to site laboratories close to manufacturing plants and to marketing departments.

...being close to the customer is a state of mind more than a matter of physical proximity.

BMW and Renault have build "techno-centres" to foster car development. This, unfortunately, is often difficult to achieve as the history and geographical spread of a business make it difficult to concentrate activities in this way.

In addition, in order to stimulate informal contracts laboratories should not be kept too large. The optimum seems to be around 400 to 700 employees in total - professionals and support - per laboratory. The argument for "closeness to the customer" is often overdone, however. In the past 20 years, Japanese car and consumer electronic companies have developed products that have been very successful in the world's marketplaces even though the Japanese themselves have set up units in the West to monitor consumer taste, notably in car styling, being close to the customer is a state of mind more than a matter of physical proximity.

Distributed Innovation systems

We need to think of innovation as a multi-functional, multi-site process in which marketing and manufacturing staff are fully part of the process alongside their R&D and engineering colleagues. There are also a number of good reasons why development centres should be established far away from the "home base".

Manufacturing-ushered R&D presence

This is where a manufacturing plan develops its procurement activities, benefits from local logistics capability and, from there, expands into specifications of sub-systems of components.

It naturally tends to climb up the value chain, developing its own product engineering unit in order to be increasingly involved in product adaptation and maybe even in product design and development.

The need to work closely with local players

A company wanting, for example, to develop composite materials for Airbus planes would be well advised to do so close to its clients - the designers and builders of the aeroplanes.

In the pharmaceutical sector, which is government regulated, a global company should endeavour to have a drug development presence in the two largest healthcare markets in the world - the US and Japan. Indeed Merck, Glaxo-Wellcome, Novartis, Roche, Hoechst Pharma, Rhone Poulene-Rorer do so.

This ensures better alignment between new drugs and regional requirements as well as faster agreement by the local regulatory authority. Similarly, a food company needs to understand the specifics of local taste as well as local ingredients and thus must, at the least possess a local product adaptation capability.

Examples of this include Nestle's decentralised R&D centres or the recently established Campbell Soup development facility in Hong Kong.

The need to tap local R&D talent

Multinational companies in relatively small countries such as Sweden cannot hope to stuff their R&D laboratories with Swedish graduates. They are therefore forced to expand internationally.

This is the case with Ericsson: in 1980, 85 per cent of its R&D activity was based in Sweden, but by 1990 the figure was only 60 per cent.

The shortage of software engineers in the United States (estimated at about 190,000) explains the drive to tap into India's abundant talent in this field; software products constitute one of India's top exports.

...shorter life cycles of products... are driving a rapid price erosion (up to 20-30% per year)...

Presence in a crucial market

A company active in computer peripherals, multimedia/entertainment or internet-associated software should probably have a presence in Silicon Valley. Philips followed this logic when it set up a multimedia lab in Palo Alto.

The key here is to have a sophisticated presence in a region that shapes not only technical developments in, but also the future of, an industry as a whole.

The need to attract the best talent

In addition to a company's reputation, the quality of the infrastructure and of the environment is an important factor

in attracting talent, especially where spouses need to find jobs.

Political reasons

A country already hosting a production plant can put pressure on a company to establish an R&D presence in order to demonstrate long-term commitment and its willingness to create knowledge intensive jobs.

The shape of things to come

Technology companies around the world must learn to handle their innovation process in an increasingly effective way because of the following pressures:

- The shorter life cycles of products, manufacturing processes and service offerings are driving a rapid price erosion (up to 20-30 per cent per year) and a slide into commodity business. The personal computer industry is a recent example of this rapid evolution. In the future, cellular phones might be another.
- Deregulation (for example, telecommunications and transport) or re-regulation (health care) constitute another powerful factor for change. For example, pharmaceutical companies are squeezed between government-driven health cost containment measures and the rapid escalation costs (clinical studies in particular) of bringing drugs to market - $600m on average.
- Know-how brokering: technology-intensive companies, rightly recognising that much more development activity takes place outside the company than inside, must be relentlessly curious about external sources of technology.

  They need to be adept at scanning, identifying, acquiring and internalising relevant expertise that may exist in competitors, universities, government laboratories or along the supply chain.

  The technology-intensive company must thus learn to be more effective tapping into and assimilating the relevant flows of technical expertise across borders and technical disciplines.
- It is not yet clear how the economic crisis in Asia will affect the issue, but the region certainly has the potential to become a major contributor to technology flows. Some countries in Asia see technological development as a key element in boosting their economic development.

Because of these changes, the need now is to energise the innovation process in a global way. This means that a firm's distributed locations must fully act as sites for technical market intelligence. And they must do this in close connection with other locations around the world.

Instead of being essentially functional and/or regional, such a process encompasses a multi-functional, multi-site perspective in order to give more power to the innovation process. This points to a potentially crucial role for information technology. Multi-functional teams of technical, design, marketing, finance, production, legal and public affairs staff can be truly integrated through electronic means in a seamless, electronic space.

The electronic media involved include intranets, group wares and intelligent agents, CAD-CAM (Computer Assisted Design/ Manufacturing) and project management software tools, and video-conferencing.

Teams in Paris, Tsukuba and Oregon will be able to work together, sharing - in real time - speech, computer data and graphics.

This "live" and "synchronous" multi-media communication may, though, play havoc with the sleeping habits of team members and "asynchronous" communication is often preferred.

The "24-hour laboratory" - a concept that actively makes use of global time differences - provides exciting possibilities in this regard.

Take the example of a distributed team of software engineers located in Bangalore, Palo Alto and London working on the development of a piece of software. At the end of the working day, the Bangalore group downloads it work to the London team, which is in turn picked up by the Palo Alto team.

Software development is particularly well suited to this kind of round-the-clock development. But Canon is also using this approach in its new "product development initiative", headquartered near Tokyo, which draws on a distributed technical community in Europe, North America and Japan.

The concept, however, has enormous scope for many types of technical development where data transmission and time-shared graphics can be put to work. To some extent, it erases geographical and organisational constraints, drawing on the best talent wherever it is located. Moreover, it results in considerable speeding-up of the innovation process.

We are... only at the beginning of our understanding of how best to use the portfolio of communication media available.

Although not a very large company, the Japanese electronics manufacturer Ricoh (with a turnover of $5 billion) has development sites in Japan, eastern France and California for its new photocopiers and cameras. Since 1995, collaboration of teams across these sites have been made more effective by connections through an intranet and groupware serving 3,000 terminals.

The $36 billion engineering company ABB has set up a Lotus Notes-based electronic space connecting its 20,000 engineers to facilitate the bottom-up emergence of new ideas. To date, more than 70,000 employees use the system more than once a day.

We are, however, only at the beginning in our understanding of how best to use the portfolio of communications media available. At what particular juncture should a telephone contact be preferred to an e-mail? When should a "broad band" face-to-face meeting be called in order to deal with a complex issue or to recharge the emotional commitment of a team?

We also need to design new management processes and organisational devices in order to take full advantage of information technology. Most of the time we lay IT on top of existing processes instead of re-designing for IT.

Dr Georges Haour is professor of technology management at the international business school IMD. Formerly manager of the research department at the Battette Institute, Geneva. Interests include global management of technology and growth through innovation and R&D.

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