PRIME MINISTER'S SCIENCE, ENGINEERING AND INNOVATION COUNCIL

THIRD MEETING - 25 JUNE 1999

AGENDA ITEM 4

STRENGTHENING THE NEXUS BETWEEN SCIENCE AND ITS APPLICATIONS

Background

The working group on *Strengthening the Nexus Between Science and its Applications* was created as the Prime Minister's Science, Engineering and Innovation Council recognised the clear link between successful science- and technology-based innovation and Australia's economic prospects. The Council was concerned that factors affecting commercialisation of science and technology need to be addressed if Australia is to be economically competitive.

At the December 1998 Council (PMSEIC) meeting, the working group presented a report addressing issues of:

- Education in Science, Technology and Entrepreneurial skills;
- Government Programs to Encourage Innovation; and
- Venture-Seed Capital for Emerging Growth Businesses.

The December 1998 discussion of these issues focussed strongly on Australia's taxation regime, particularly capital gains tax, as a major impediment to capturing the benefits from the growth of high technology industries. The recent discussion paper, *A Platform for Consultation* released by the Review of Business Taxation and chaired by Mr John Ralph, has indicated that the taxation regime may be changed in the near future. This is likely to improve the opportunities for successful commercialisation which scientists, technologists and entrepreneurs have advocated for some time.

The working group has now addressed the issue of whether Australia will be ready to capitalise on these new opportunities. Will Australian innovators be able to make a positive impression on potential investors? Or will they be unprepared for the opportunities arising from the new business environment, and reinforce the impression of Australians as brilliant scientists and technologists but poor managers of the commercialisation of its outcomes? We should not assume that Australians will be prepared for a new environment of investment, or that we automatically possess the capabilities to manage emerging opportunities effectively.

For this reason the working group has developed a new focus in preparing this report.

New Terms of Reference

The new terms of reference for the working group reflect this new focus and are:

- To monitor outcomes of recommendations made to the 4 December PMSEIC meeting with regard to primary and secondary science and technology education. (see the paper under Item 4)
- To investigate tertiary education activities which develop people skilled in commercialisation of science and technology.
- To encourage education in innovation at all levels of education and in the community at large.

The working group believes that government needs to be pro-active in anticipating changes; identifying areas in need of improvement; identifying gaps which should be addressed; and identifying best practice examples which can show the way for scientists, technologists and entrepreneurs in technology-based emerging growth businesses. This report identifies areas of Australia's innovation system which need to be addressed for the new environment in which our scientists, technologists and entrepreneurs will find themselves, and proposes initiatives which should achieve positive outcomes.

Key Factors in the Environment for Innovation

The working group has identified five areas which are essential to providing an environment conducive to innovation. These are:

1. Primary, secondary and tertiary education in science, technology and enterprise;
2. Proving technology and developing working prototypes;
3. Support to continue development;
4. Educational support to introduce management structures; and
5. Support for legal advice to protect intellectual property, commercialise ideas and ensure that there is return to investment for Australia.

(These incorporate ideas proposed by the Australian Quality Council's business excellence framework.)

The path that innovators will choose is often complex and rarely linear. However, all factors must be working effectively if Australia is to create an environment where people can access the finance and support programs which they need to innovate and to capitalise on their innovations for their benefit, and that of the nation.

Primary, Secondary and Tertiary Education in Science, Technology and Enterprise

Investigation into primary and secondary science, technology and enterprise education

The reports to PMSEIC on the nexus between science and is its applications, on 29 May 1998 and 4 December 1998, both identified science and technology education as major priorities for Australia.

The key issues identified by those reports were:

- The quality of education for science and technology teachers needs upgrading;
- The structure of teacher training degrees needs to focus on the innovation process;

- The general lack of education of science and technology students in aspects of the commercialisation of science and technology; and
- The identification of best practice examples in the States and Territories in the above areas which could have great effect if given wider application.

This year the Minister for Education, Training and Youth Affairs has provided funding for studies which will investigate the current quality of teaching and learning of science and technology in upper primary and early secondary schooling in Australia. This study will form the basis for discussion about the development of approaches and future directions in science and technology education.

The working group congratulates the Minister and Department of Education, Training and Youth Affairs (DETYA) on this important initiative The commencement of these studies is an extremely important step forward in addressing the issues raised by the working group.

The Enterprise Education in Schools (EES) Initiative was introduced in 1996-1997 to promote skills in enterprise in primary and secondary school students. Funding of $3.4m over 3 years to 1998-1999 was provided with the agreement of Commonwealth, State and Territory Education Ministers.

An evaluation of the initiative which commenced in January 1999, is expected to identify issues for further consideration in the development of any future Commonwealth policy directions in this area. The evaluation is due to be completed in June 1999.

The working group supports enterprise education in schools and encourages interaction between science, technology and enterprise education as a vehicle to make students aware of the factors involved in innovation.

Professional development of teachers

The training of primary and secondary teachers in enterprise, science and technology, needs to demonstrate the integration of these in, and their relevance to, situations which actually occur in industry.

The working group's last report found that many current primary and secondary level science and technology teachers have outdated or insufficient science and technology qualifications. Because science and technology have progressed so rapidly over recent years, and there has been a lack of funding for career development, teachers' skills have become out-dated and irrelevant for teaching the skills students will need in the world they will enter.

Supplementary courses to update and increase teachers' knowledge of science and technology are vital if they are to be provided with the skills relevant to teaching today's students.

Most teachers also have inadequate training to teach the relatively new field of enterprise education. Teachers who are provided with supplementary training in this area understand not only science, technology and enterprise development but also the linkages between these subjects within the innovation cycle. Cross disciplinary learning, is essential to solving real problems, while also complementing the existing curriculum requirements..

Students and teachers alike can be motivated by working with leading edge technology development projects. For example, at the Australian Technology Park music students from the Conservatorium High School had the opportunity to gain experience in high-technology companies, 30% of students changed their career path, opting for high-technology careers

instead of in music. The E-Teams project of the Australian Quality Council, and other enterprise-based educational activities such as the Young Achievers Awards have also met with great success.

Appendix 1 presents a proposal for professional development of teachers which would help achieve these goals.

The Government should provide targeted funding for teacher development in these fields to ensure the time, effort and money which is put into education is not wasted in teaching outdated knowledge with methods which are no longer relevant to today's society.

The best time for the Government to address these issues is now. Although it can be argued that the impact of these recommendations on Australia's economy will take time to realise had such ideas been taken up fifteen years ago, we would be in a much better position today. If they are not taken up now, in the next fifteen years it may be too late for Australia to be supplied with the people who can operate in a knowledge based economy.

Recommendation

1. **To increase the effectiveness of primary and secondary education in science, technology and enterprise education, the Government should provide targeted funding for supplementary training for teachers in project-based and enterprise development science and technology which could include secondment of teachers for short periods into industry.**

   Such training courses would be best developed by a committee of experts including people who have already demonstrated excellent results, such as representatives from a National Schools Network Team.

Establishment of a Young Inventors Competition

The working group believes that a further way to encourage young people to learn about using science and technology innovatively would be to hold "young inventors" competitions for both primary and secondary levels. Initially this might be done as a pilot scheme, possibly being run by the Queensland Science Centre which is developing a proposal for such an activity. If successful this could be expanded to a nationwide competition. Such a competition might include prize money of $10,000 each for approximately 50 students around Australia. This relatively small cost to government would be great incentive to young people to develop skills in areas vital to Australia's future.

Tertiary education to develop skills in commercialisation of science and technology

The working group has carried out a survey of Australian universities to help determine best practice examples and perceived gaps in developing skills in commercialisation of science and technology.

Positive activities in universities which encourage students included:

- Flexible degree rules, with cross-faculty structures, allowing joint science and engineering, and business/management, courses;
- Some specialised subjects have been developed for students of science and engineering which also cover innovation, commercialisation and establishment of small companies;

- Increasing links with industry, including involving students in the Cooperative Research Centres (CRCs);
- University companies which facilitate technology transfer from the university to industry;
- New skills programs specifically designed to teach management of research. Examples include the Leadership in Innovation Program operated by the CSIRO/Business Higher Education Round Table; and
- Enhanced international collaborations through bilateral consortium arrangements.

Disincentives which discourage students from developing skills in commercialisation were identified as:

- Lack of staff time to make connections with industry due to extra teaching loads;
- Lack of funding support to increase linkages;
- No long term view by industry in supporting undergraduate and postgraduate students;
- Poor understanding by university personnel of the constraints of industry partners;
- Lack of resources to develop more integrated cross-disciplinary topics;
- Lack of industry experience on the part of university staff; and
- Reduced funds for science and engineering education infrastructure requirements.

The universities also identified the following, broader factors which inhibit students' interest in developing skills in commercialisation:

- Lack of adequate venture capital for start-up companies arising from research successes;
- Lack of technology incubator centres for entrepreneurs;
- Difficulties with the handling of intellectual property rights;
- Internationally uncompetitive tax regime and R&D incentives;

In considering these issues for Australia, it is worth reflecting on the practice in overseas countries. Several different international models of best practice exist. However, they all share the same basic characteristics:

- Excellent two-way flow of people between the research community and industry;
- Very strong integration of research, education and business activities;
- Access to best practice technology incubation and management training; and
- Access to significant quantities of venture capital.

Providing both students and teachers with access to the sorts of training advocated in this paper would also help to address these problems.

The working group's previous paper mentioned several full-time courses available in various aspects of entrepreneurship. Although these are positive initiatives, there is still a need to inform more postgraduate scientists of these programs, and provide them with access to mechanisms to commercialise the results of their research.

While some universities are already offering such courses, the working group believes that Government should more actively encourage all universities to offer training in skills such as intellectual property management, feasibility studies, business planning. This could be made available to all PhD students and any more senior researchers who want to take advantage of it. There is evidence that patent attorneys, venture capitalists and others are keen to be involved.

Decline in University Funding

The support of basic research is a legitimate role of government, with innovation and commercialisation being dependent on good fundamental research. A thriving university research sector would support industry's development towards a knowledge-based economy, and create wealth for Australia.

Clearly there is scope for improvement. Research and development requires investment in equipment, computers and salaries. Increased investment in higher education infrastructure and staff time would be a positive way to improve the situation

Recent budgets have failed to provide any real increases in funding to universities, and in some areas there have been decreases. Support for research in the higher education sector (excluding support from special purpose grant schemes) is estimated to be $1635 million in 1999-2000, a real decrease of about three per cent. Basic research as a proportion of all research has been in decline in Australian universities since 1992 and the Federal Government no longer funds salary increases negotiated through enterprise bargaining in universities. In addition, the value of block grants to universities has declined significantly in recent years; they are now 15% less than their 1996 value. There was no provision in the most recent Budget to restore Australian Research Council funding. Support for university infrastructure has dropped in real terms. Given that 60% of all basic research in Australia is conducted in universities, this decline will have a significant impact on Australia's fundamental research capability. [1]

Redundancies and forced retirements have led to declines in many university departments. These departments are overloaded, as they attempt to balance quality teaching and research. Science and engineering suffer the most from this, due to their higher infrastructure and running costs.

These constraints, insufficient stipends or scholarships to support them through their postgraduate science studies, and a lack of research positions, lead talented students to reject science for other careers.

Recommendations

2. **Universities include in their performance evaluation criteria, cross-disciplinary studies and entrepreneurship training.**

3. **Government provide extra targeted investment for Australian postgraduate awards which include a stipend and a component of training in commercialisation of innovation.**

4. **Government provide increased investment for both infrastructure and staff in science and technology education.**

Proving technology and development of working prototypes

Developing and proving technology and producing working prototypes of that technology is a vital stage in the innovation process. The working group is concerned that there is insufficient venture capital and a lack of knowledge of how it might be raised by innovators at this stage.

[1] Figures taken from Science and Technology Budget Statements and The Business/Higher Education Round Table "The Case for Additional In vestment in Basic Research in Australian", April 1999

Evidence of lack of available venture capital for development stage of innovation

There has been much speculation of a perceived gap in finance for the earlier stage of innovation. Universities cited in our survey listed a wide range of problems which occur at the stage of developing the technology and creating a working prototype from a new idea. Problems associated with this difficult stage of the innovation process include a lack of funding, a lack of expertise, and a lack of a supporting environment.

The Commonwealth Government's Innovation Investment Fund (IIF) Program represents an important response to the problem of a shortage of early stage venture capital in Australia. Under the two rounds of IIF so far, more than $340m in venture capital has been approved for investment in technology companies. While the working group welcomes this initiative, it is aware that IIF will not support very small firms at the "pre-seed" level of development.

There is clearly a continuing gap in the Australian market. Many overseas countries have successfully addressed this gap through the mechanism of technology incubators.

The "Investment Readiness Study" undertaken for the Department of Industry, Science and Tourism in 1997 identified a perceived equity finance gap. In this study, consultation with investor groups confirmed the existence of an equity availability gap in the market. This gap was seen to be in funding the $0.5m to $2.5m capital requirement, falling between the comfort level of the "business angel" sector and the Venture and Development Capital investor groups. The report says in part:

> "The limitation for the Business Angel was generally their available funds and exposure to one investment. For the Venture and Development Capital funds the limitation was based on the cost of evaluation and ongoing monitoring of the smaller investment which was seen to be prohibitive commensurate with the risk.
>
> This gap equates to the early stage investee group where the risk level is seen to be high. The Pooled Development Funds (PDF) have been focused into this area to provide an additional source to meet the gap at the upper end."[1]

and goes on to explain

> "The Equity providers require a very high rate of return from their investment in the SME business, being around 25-30% per annum over 3-5 years. Given the high return requirements of equity investors, there is clearly a gap between a business which can meet the security requirements of the banks to access debt finance, and reaching the next stage of eligibility to meet the rate of return requirements of equity investors.
>
> SME's who are between the debt parameters and have not yet reached the equity investor parameters of return on investment, present a problem for the SME sector.
>
> This segment of the SME market is likely to represent an important contribution to economic growth in Australia, export activity and strong employment opportunities. Its growth will be limited to its debt raising capability unless the equity market is prepared to reduce its expected rate of return based on a lower evaluation of market risk."

The report, however, does not attempt to ascertain the size of this gap, stating that "The extent of this important segment of SME's has not been researched to determine its economic significance." [2]

The working group is concerned that this gap is a significant obstacle to commercialisation in Australia. It has also identified a gap at the earlier, development stage of innovation from $50,000 to $500,000. This gap may indeed be extremely large and the working group has sought to demonstrate how large the problem is. We have identified some indicators which lead us to believe that the problem is much larger than previously thought.

This is especially worrying as it is those companies at the earliest stages in their most vulnerable state to which informal venture capital (provided by individuals, small syndicates or corporations) is most important. These are the companies which are most likely to be based on innovative research and may be sold overseas if venture capital cannot be raised in Australia.

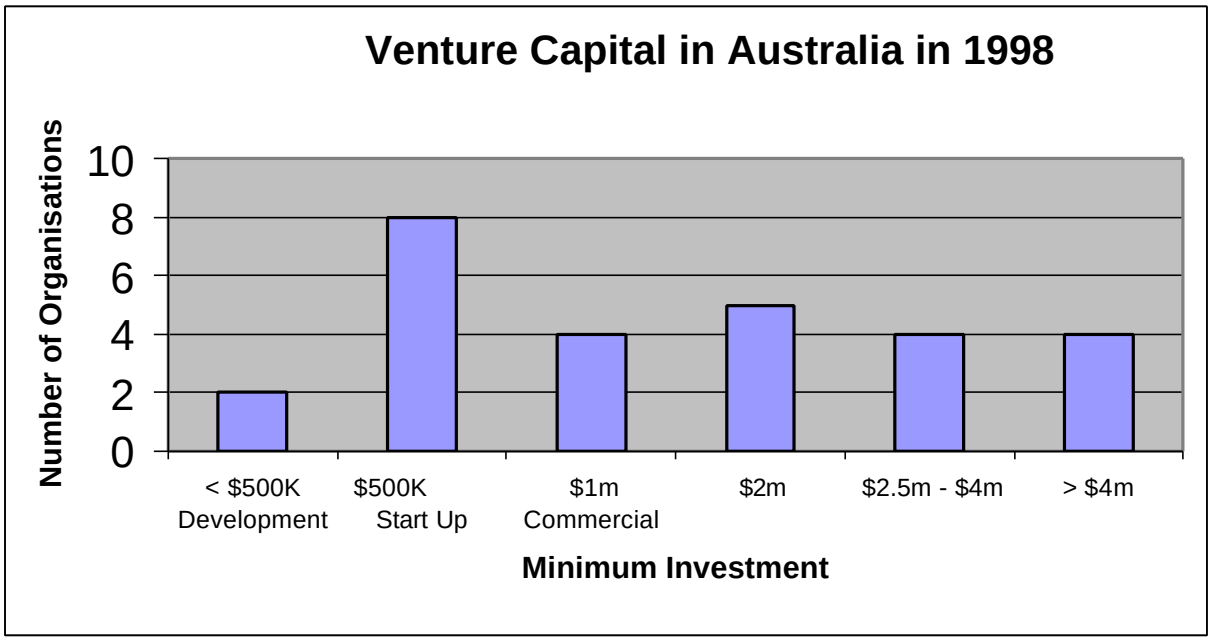
One indication of the extent of this problem can be gained through a comparison with the situation in the USA. In 1998, in the USA the total funds available per head of population through formal venture capital providers was around $3 per head of population. In the same year in Australia the amount was $1 per head of population. This discrepancy, while not large, is nevertheless significant although, generally speaking, Australia is well placed compared to many other OECD countries in this respect.

However, in the area of provision of informal venture capital , the US funding was around ten times the amount of formally provided venture capital. In Australia by comparison, the amount provided through informal sources was half that provided formally. As a result, total venture capital available in the US per head of population is around $33 while in Australia it is around $1.50.

A recent survey of its membership conducted by the Australian Venture Capital Association Limited (AVCAL), and reported in the newsletter *R&D Review* of February 1999 provided information on venture capital organisations, and the stages of development of R&D they were willing to fund.

A graph showing the minimum investment which these organisations were willing to make is presented below. This shows that in the development stage of investment there is only a very small number of organisations prepared to make funding available.

[2] From Investment Readiness Study - Small Business Research Program by Ernst & Young - Gillian Walker for DIST April 1997.



Rejection of R&D Start Grants at the development stage of innovation.

One mechanism which the Government provides to address the problem of a gap in venture capital in early start-up businesses is the *R&D Core Start* program administered by Department of Industry, Science and Resources (DISR). To receive funding for R&D projects under *R&D Core Start* , eligible firms compete for funding based on five merit criteria, including the management capability of the firm. Experience after two years of this Program indicates that the lack of strength in management capability is a significant factor in companies which either do not apply for Grants, or are ruled out in the competitive selection process. This applies particularly to many smaller firms. There is also evidence that weaknesses in management capability are significant explanations of the failure to commercialise the outcomes of some of the projects that have received Government support. The Program requires that the applicant raise 50% of the project cost themselves and demonstrate a marketing plan developed to an advanced level.

A survey has been conducted by the working group of applicants for Program Grants in 1998. There were 243 applications in that year. Of these 142 were accepted, 96 were rejected and 5 were withdrawn. Of the 96 rejected, 50 were rejected as they were at too early a stage of development, and/or had not been successful in attracting sufficient capital. The remaining 46 were rejected for other reasons, such as insufficient innovation or poor quality research.

The large proportion of applicants who have shown good technical innovations but who need further financial and management support at the early stages of development indicates a clear need for assistance. It is fair to conclude there would be many more potential applicants, who declined to do so because they were at too early a stage of development and/or were not able to raise sufficient capital to satisfy the requirements of the Start Program.

An Approach to Development Stage Funding

One of the handicaps for our young entrepreneurs is the gap between an NHMRC or ARC grant and early stage venture capital. Seed funding is needed to provide proof of principle, to exemplify patents, and to prepare business plans. A mechanism is needed to provide this stage of development with seed funding in the $50,000-$500,000 range.

Appendix 2, A and B presents two different possible mechanisms to fill this gap. The first is a seed funding mechanism developed by the working group. The second is a proposal by The

Australian Academy of Science's in its submission to the Review of Approaches to Greater Commercialisation and Self-funding in the Cooperative Research Centres (CRC) Program, November 1997.

Recommendation

5. There is a real need to address a lack of funding and education at this very early phase of innovation. This problem requires further examination and should be addressed by the National Innovation Summit.

Support to continue development

Once the proved technology-working prototype phase of development has been completed, there is a clear need for competence in continuing development, gaining access to larger amounts of venture capital and developing a preliminary business organisation.

Many firms may have a product with great potential, but the firm itself may not be an attractive proposition to investors, or indeed may not yet be at the stage where it should seek venture capital. The view of many Australian financiers is that the poor quality of potential ventures is a greater problem than risk aversion on the part of the financial community.

The 1996-97 *Innovation in Manufacturing* survey conducted by the Australian Bureau of Statistics found that 26% of manufacturing businesses in Australia had undertaken one or more technological innovation activities in the period 1 July 1994 to 30 July 1997. In the previous three year period this figure was 32%. This fall was most significant in firms with less than ten employees. One of the elements identified in the study as hampering the commencement of projects was "excessive risk perceived by the business".

DISR is currently considering a new proposal for a program to address commercialisation of innovation. By improving management skills, the proposed program will improve firms' ability to make informed judgements in the area of risk. The proposed program will provide critical support to enable individuals, early growth firms and spin-off companies from public research institutions, to manage innovation and its commercialisation, with particular emphasis on attracting equity investment. (See Appendix 3)

The working group believes that such a program has merit in meeting the needs during the continued development phase of innovation. It will need to be managed to ensure that it does not duplicate aspects of programs which already operate, such as the Enterprise Workshop Program, an initiative of DISR which is operated by the State Governments.

The proposed new program from DISR is on a very small scale, and focuses only on education and management assistance, not on provision of venture capital. While the working group feels that this is a step in the right direction, an initiative on this scale would be insufficient to have a major impact on the innovation system in Australia.

Recommendation

6. Programs which address the needs of this continuing development phase of innovation be encouraged.

Educational support to introduce management structures

The working group has identified a fourth major factor in the innovation process. This is educational support to introduce management structures. Once the innovation process has started, the phase of rapid business growth which often follows can be the most difficult time for innovators. Many of the skills required to manage this stage will be different to those of the previous stages.

An appropriate vehicle to educate managers would cover seven areas. The first is the leadership role. Innovators are not necessarily able to take the next step of leading and managing organisation.

The second is strategic planning. Assistance in this are would include support for a strategic business plan and market research.

The third area is information and analysis which includes the ability not only to manage cost process but also to set up reporting mechanisms both internally and externally to the organisation. - in short business systems.

The fourth area is people management. Skills are vital in human resources development to ensure the organisation can proceed to the next step through continuous learning in all aspects of the organisation.

The fifth is in understanding processes and services. It is important to develop an understanding the mechanisms of products measurement of success towards continuous improvement including:

- Structured process for achieving excellence in products and services;
- Partnerships with stakeholders and suppliers;
- Flexibility to enhance and continuously redesign processes, product and services;
- A culture of innovation; and
- Measurement of variation.

The sixth is the ability to research customer base and set performance measures for customer base and set performance measures for customer satisfaction.

The final is an understanding of organisational performance and setting performance targets for the organisation.

Providing education in these areas would ensure that start-up companies will have a greater chance of success, and growing companies in new industries will be strategically placed to manage growth.

Recommendation

7. Government consider (possibly through the Innovation Summit) whether the appropriate educational mechanisms are in place to ensure that innovators are sufficiently supported during the early growth phase of their operations.

Support for legal advice to protect intellectual property, commercialise ideas and ensure that there is return to investment for Australia.

It is important to ensure that the benefits of innovation will be returned to Australia and not lost overseas. To enable this to happen it is essential that innovators have access to provision of legal advice and representation in areas such as protection of intellectual property and commercialisation of ideas.

An example of the problems which can arise is demonstrated by the recent proposal for changes to the Trade Practices Act (TPA) relating to intellectual property. The National Competition Council (NCC) has completed a draft report which referred to section 51 of the TPA which was presented to the Treasurer and to the Minister for Financial Services and Regulation on 5 March 1999.

The draft report recommends the repeal of s51(3), which provides a limited exemption from Part IV of the TPA for transactions relating to the use of intellectual property. The working group feels that this recommendation would create a further barrier to commercialisation of research and may force some commercialisation activity offshore.

The NCC has concluded that very few intellectual property agreements rely on s51(3), and those that do could utilise the authorisation process that exists in the TPA. ANUTECH and others dispute the NCC conclusion, and claim that a significant proportion of their intellectual property agreements rely on s51(3), and that the authorisation process represents a significant cost barrier. Furthermore, the repeal of s51(3) would send a wrong signal from Government to the entrepreneurial community.

The legal issues involved in starting up businesses and protecting innovations are complex. In the early stages of innovation, both access to funds and awareness of the need for, legal protection is not always available to entrepreneurs and researchers.

Recommendations

8. **Government consider mechanisms which would enable and encourage innovators to gain access to legal advice in areas such as the protection of intellectual property and commercialisation of ideas.**

9. **Government reject the recommendation of the draft report of the National Competition Council for the repeal of s51(3) of the Trade Practices Act. S51(3) provides limited exemption from Part I of the Act for transactions relating to the use of intellectual property and commercialisation of ideas.**

Technology Incubator Proposal

In examining the various stages of innovation, the working group realised that a solution which addresses the different stages of innovation, and strengthens the linkages between the people involved would be most effective in encouraging innovation in Australia.

An Australia-wide network of technology parks accommodating technology incubators could provide strategic assistance to the education, management training and assistance, seed capital provision and legal assistance stages of innovation. Such a network could provide educational opportunities for primary, secondary and tertiary level students in science, technology and enterprise development.

Innovators who have developed a product to the proof of concept stage face difficulties in moving on to the commercialisation and business development of this innovation. The technology incubator structure has been demonstrated around the world to be an excellent mechanism for helping start-up firms through this difficult stage.

While Australia has many business incubators, there are currently very few technology incubators. Those that do exist have proved highly successful in encouraging linkages between research organisations and industry. For example, the Australian Technology Park, have successfully graduated twelve companies from its incubation program with a total estimated value at the time of graduation of $5.5 million.

The working group believes an appropriate number of technology incubators for Federal Government to support in Australia would be 30. In Israel, their program initially funded 28 incubators, 26 of which are still operational today. The Israeli system has proven highly effective in generating knowledge-based companies.

This would allow technology incubators not only in the major cities but also in regional areas where the infrastructure necessary to encourage start up businesses is often less accessible. It may be possible to tap into regional strengths or address particular needs by installing compatible incubators in close proximity to each other and/or to appropriate industries or educational facilities. If done well, this may have the effect of encouraging the formation of clusters of business, and educational institutions. By strategically locating the technology incubators, a multiplier effect on positive outcomes could be achieved.

For such a program to be successful, it is necessary for the incubator funds to be channelled through an experienced manager who has control over these funds and can help to install good management practice into those less experienced in business management.

The advantage that the incubator mechanism is that it provides both encouragement of innovation and SME development and educational experience.

Incubators could provide funding for the difficult technology development stage of innovation and start-up stage.

The cost of running 30 incubators is estimated at around $50 million per annum. The incubators could also be used to help create interactions with primary, secondary and tertiary level students in real life examples of start-up companies which have developed innovation to successful commercialisation.

The initiation of a major incubator program for Australia based on world best practice model would be a mechanism for solving the major problems identified by the working group. Such a program would:

- address the lack of available capital for the development and early start-up stage of the innovation cycle as well as a lack of linking mechanisms to help innovators;
- assist entrepreneurs and researchers to work together to educate each other and commercialise new innovations;
- assist existing industries and larger firms in uptake of modern technology and in updating the skills of their employees; and
- address problems in teaching primary, secondary and undergraduate level tertiary students an understanding of all the processes involved in the innovation cycle.

For a more detailed description of this proposal see Appendix 4.

As well as such a program it is important the Government addresses the recommendations made in the working group's report regarding the restrictive Capital Gains Tax which prevented a flow of venture capital, and a less than perfect R&D Tax Concession which did not effectively support small start-up businesses. Again we would emphasise the importance of the R&D Tax Concession for both small and large businesses innovation in Australia.

The recent figures released by Australian Bureau of Statistics on business expenditure for research and development showed that there is a continuing decline in spending in Australia. We must remember that research and development is worthwhile, and that it is most important to encourage the linkages between research and development, and commercialisation. It is obvious from these figures that across the board funding for research and development such as provided by the R&D Tax Concession is very important and we cannot simply rely on incremental funding for R&D, as some suggest, or discrete grants to selected firms.

Industry will only fund research and development if it proves competitive to do so. This is because industry has trouble capturing all of the benefits from research.

Once the tax issues are addressed, the technical incubator model, if carried out at an appropriate level of activity in all areas of Australia, would offer an excellent solution, offering the opportunity to address several issues with one mechanism.

Recommendation

10. The Government address the issues of Capital Gains Tax and the R&D Tax Concession raised in the working group's report of 4 December 1998.

11. The Federal Government provide significant investment in a strategic technology incubator program for Australia.

Conclusion

As we move into the next millennium, Australia must to be at the leading edge of innovation to capture the opportunities offered to knowledge-based economies. For this to happen we need a holistic and interactive approach to innovation. We need to ensure that the mechanisms and support necessary for innovators to carry through their ideas to realisation are provided. The recommendations of this report would help achieve the outcomes Australia needs.

Appendix 1

Professional Development of Teacher's Proposal

Some features of these learning experiences are envisaged as described below.

Teachers from various disciplines collaborate on the project. The project (say one or two for each year of study) would be formulated to include specific parts of the syllabus, in say mathematics, physics, music, business studies or other.

Problem-based learning and exploratory units are designed and presented around the project's theme through the medium of interactive computer and/or video programs.

In the project, the concepts developed in the subject areas would be needed to bring the project to a successful conclusion - eg to understand how something that they make functions, or how it can be varied, or how to do the calculations necessary to shape or formulate it, how to write the text or poem for marketing, or as part of its enjoyment.

The design of the projects will encourage a real spirit of experimentation, lateral thinking and responsible risk taking, as well as an awareness of societal and global priorities.

Teachers work in teams, sharing their expertise and supporting each.

Students work in teams, so they can each build on their natural aptitudes and strengths and in the process strengthen their knowledge and abilities where they are weaker.

There are ongoing assessment processes included in the units of study - partly to get the students to reflect on their own learning, partly to make sure that they are aware of the skills and abilities they are building and partly to identify where they still need to acquire further skills and knowledge.

The content areas of the projects are examinable internally or externally. This should reassure the parents and community (as well as some teachers) that 'real learning' is taking place during the projects.

In order to base the projects on real life situations, they could be developed in such a way that they require collaboration between an organisation - manufacturing, retail, service, non-profit etc - and the school involved. The collaboration could vary from a visit to the industry by a group of students to the students being called in to analyse and redress a problem that the organisation has identified. This would further encourage closeness of nexus between industry and schools.

Participation in the projects would become a recognised professional development activity for the teachers, to serve as an incentive for implementation.

The National Schools Network should be refinanced in order to allow it to debate, develop and distribute the units of work for the professional development of teachers throughout Australia.

Appendix 2

A - Possible Seed Funding Mechanism

A program to address the needs of very early stage, seed funding might be based on a mini-Innovation Investment Fund (IIF) model, with seed investor funds matched by DISR, targeting selected universities or other research organisations.

Such a program would:

- Provide seed capital of $50,000-$500,000 to commercially promising research projects;
- Link this funding to commercial/management guidance;
- Ensure quality of project selection by sourcing a percentage of capital from investor groups;
- Attract these investors by leveraging on dollar for dollar basis (as in START) or Capital Gains Tax relief (as in Pooled Development Funds); and
- Select investor groups focussing on specific research area/geographic region/institution.

This might be achieved by allocating funds from Industrial Research and Development Board resources to a new class of investment entities called Seed Funds.

These seed funds would be commercial entities formed by investor groups comprising business managers, and "business angels" with around $1m per annum in discretionary investment capital and a mutual interest in investing in a particular institution, research area or region.

Each seed fund would be eligible to apply to the IR&D Board for matching funds based on their selected investment strategy, rather than on individual projects. In other words, they would be selected partly on the basis of their commercial/management skills, and partly on the quality of the research base in which they propose to invest.

Each seed fund would have the capacity to invest in four or five ventures per annum ($1m of their own funding, plus $1m of matching funds from the Government). The returns on these investments would accrue to the seed fund, ie equivalent to a dollar for dollar Start grant awarded to a company.

In cases where a seed fund focussed on a specific institution, the investor group might choose to establish an investment committee comprising members of the investor group and the investee institution. This would help ensure selection of quality projects, and would develop streamlined mechanisms for evaluating relative equity levels.

Comparative studies reveal that Australia has the capacity to create at least 100 companies per annum from our universities and other research organisations, although at present the number is more like ten. The working group believes that twenty seed funds, funded at $1m each, would be sufficient to close this gap. The cost of $20m per annum would correspond to about 10% of the R&D Start Program budget.

Of the twenty seed funds that receive the initial $1m, it is likely that around half will successfully progress to the next stage of innovation. At this stage, further funding would be required for start-up venture capital requirements of around $200 million per annum (50 companies at $4m each). This funding might be obtained through the IIF scheme and would provide the IIFs with a much larger choice of investor-ready projects.

B - Enhanced linkages - The development process

A Proposal from the Australian Academy of Science Submission to the Review of Approaches to Greater Commercialisation and Self-funding in the Cooperative Research Centres Program, November 1997.

There is an apparent need for action at the development stage of innovation to enable projects which have been brought to prototype stage to be carried forward through the development phase to products which could be manufactured.

Such an extra stage is recommended so that the nation can get maximum benefit from the growing culture change and the capital already invested. We have tentatively called it a Joint Development Program. This should be thought of as a supplement to the on-going Cooperative Research Centres Program.

This second step should, once again, provide funding that is contestable in that existing CRCs which have a product, as well as research agencies and universities with developable products, could compete for the government component of the new funds. Being a facilitation process these would be relatively modest or in the form of some initial underwriting. The major part of the development funds should come from the industrial partner (or syndicate of partners) and venture capital. The provision of government funds would have to be along the lines which satisfy the prescription of the World Trade Organisation (WTO).

Such a supplementary scheme should have political attractiveness as, combined with the CRC scheme, it could be the basis of a major initiative to ensure vertical integration of the public good, pre-competitive and development aspects of a highly networked industry support scheme. The development aspect of the program could call upon different elements of the unified national system of tertiary education and the research agencies.

An enhanced scheme would also have the financial benefit of presenting a larger total scheme with a larger fraction of it (the development part) financed from the private sector. These ideas will need considerable elaboration and an evaluation of their relationship to the tax incentive and Start schemes about to be introduced by government.

Appendix 3

Maximising Commercial Opportunities for High Growth Companies

OUTCOME

To improve Australia's national performance in innovation and commercialisation of innovative R&D.

OUTPUT

Provide critical support to enable individuals, early growth firms and spin-off companies from public research institutions to manage innovation and its commercialisation.

RATIONALE

The Government's intention is to increase R&D and commercialisation by supporting the key steps in the innovation process.

Many firms may have great potential, but may not yet be at a stage where they are an attractive proposition to investors or other strategic partners. In addition, they may not yet be at the stage where they can effectively manage a process of growth or commercialisation.

The view of many Australian financiers is that the unpreparedness for potential ventures is a greater problem than risk aversion on the part of the financial community.

DISR has also observed this directly. To receive funding for R&D projects under the *R&D Core Start* element, eligible firms compete for funding based on five merit criteria, including the management capability of the firm. Experience after two years of the *R&D Start* grants program indicates that the lack of strength in management capability plays a role in companies not applying for R&D Start grants, as well as counting against many smaller firms in the competitive selection process. There is also some evidence that weaknesses in management capability is a significant explanation of the failure to commercialise the outcomes of some of the projects that have received Government support.

In addition, the 1996-97 *Innovation in Manufacturing* survey conducted by the Australian Bureau of Statistics found that 26%of manufacturing businesses in Australia had undertaken one or more technological innovation activities from 1 July 1994 to 30 July 1997. In the previous three year period this figure was 32%. The drop off was most significant in firms with less than ten employees. One of the elements identified in the study as hampering the commencement of projects was "excessive risk perceived by the business". By improving management skills, the program will improve firms' ability to make informed judgements in the area of risk.

PROGRAM OVERVIEW

The objective of the program is to contribute to innovation and commercialisation outcomes of innovative R&D in the supported companies.

One way to achieve this is to improve the capacity of individuals and early growth firms to attract venture capital or otherwise raise capital necessary to commercialise the outcomes of innovative research.

International financiers have identified six factors that they look for in deciding whether to invest venture capital in a firm.

1. Proven technology
2. A working prototype

3. A sound management team
4. Market research
5. A sound business plan
6. Intellectual property protection

The various components of the program address the ability of firms to meet the requirements of potential investors in relation to these factors.

A second way in which the program seeks to achieve this objective is to further increase the level of innovation within early growth firms through the development of appropriate management skills that enhance firms' capacity to participate in effective research and development activities and subsequent commercialisation of the outcomes.

PROGRAM DELIVERY

Program delivery will be undertaken by AusIndustry through two private sector national case managers and a network of up to ten case managers around Australia.

National Case Managers (2) responsibilities will include:

- Decision making regarding level of assistance following referral by case managers.
- Quality assurance across States in terms of types of companies receiving assistance and the quality of service provided by case managers and their agents.

Case Managers (up to 10) responsibilities will include:

- Initial assessment and recommendation of companies for assistance.
- Referral of companies to appropriate providers.

PROGRAM MECHANISMS

A. Self-Assessment phase

A preliminary self-administered assessment of the proposal that will enable potential clients to make an objective assessment of their eligibility and potential to benefit from the program. This would form part of a detailed information kit explaining the program, its objectives, eligibility criteria, costs and how to apply. The kits would be lodged with a contracted case manager for assessment.

B. Selection and streaming of suitable applicants

The case manager contracted by the department will undertake an initial analysis of the self-assessment. The case manager will select the most suitable applicants for a more detailed analysis of their potential, and make recommendations to the national program managers.

Following assessment of the case manager recommendations, those with panel approval to proceed will be returned for their program to be developed by their case manager or for their referral to a management development program.

Those unsuccessful applicants will have their responses prepared and despatched.

C. Provision of Assistance

Applicants will receive either specifically tailored assistance or undertake an existing program of management development to assist them to commercialise their product or process.

Tailored assistance plan

Eligible assistance at this level would be capped at $100 000 in the case of exceptional applicants but will, in the majority of cases, fall within a range of $20 000-$50 000. In the case of exceptional applicants, assistance could cover activities in relation to the six factors included above, and may include placement in an incubator. In the majority of cases, assistance is more likely to be directed to management, market research and strategic planning. This could also include elements of skill development described below.

Assistance in either case will be available over a maximum period of two years.

Options for assistance:

1. 100% subsidy;
2. 25 % company : 75% government contribution;
3. repayable loan; or
4. convertible notes, preference shares or royalty stream.

Skill Development

This stream is designed for companies whose immediate need is for management skills related to innovative practices and financial management of commercialisation of R&D. It is a less intensive process than a tailored assistance program.

Assistance will be for participation in existing management development programs, delivered by either the private sector or tertiary institutions. It is anticipated that $5 000 per firm will be made available on a dollar for dollar basis.

Appendix 4

Technology Business Incubation in Australia

If Australia is to be a significant player in the knowledge-based global economy, it must become world-class in innovation and the commercialisation of technology. However, Australia performs badly in the commercialisation of research and development and in generating successful technology-based spin-off companies from public sector institutions. This is often attributed to new entrepreneurs lacking the business acuity critical for their growth and continued success. It can also be attributed to the lack of an entrepreneurial culture among researchers in Australia.

Our performance in providing business development assistance for technology based start-ups, compared with other countries, has also been poor.

A proven mechanism to address these problems is the establishment of technology incubation facilities to help young companies through the start-up stages - a time when they are particularly vulnerable to failure.

What are technology incubators?

Technology incubators (also known as technology business incubators or technology centres) are specialised business incubation facilities that focus on supporting high technology-based start-up companies. They are closely managed, supportive environments where entrepreneurial companies can develop the essential management skills and systems that enable them to grow and succeed. Such skills and systems include financial management, marketing, computer systems, and technological and human resource management. Companies housed in a technology incubator tend to grow more rapidly and are less likely to fail than unsupported companies.

Aside from helping companies develop business management skills through participation in their enterprise development programs, incubators provide flexible space and opportunities to network with other entrepreneurial companies. Enterprises may also be able to access sources of finance, and link with major customers and other strategic allies. Companies generally stay in an incubator for two to three years.

One key difference between these and general purpose business incubators is that technology incubators generally require much more money to develop start-up firms. This is because high technology firms often require highly specialised R&D infrastructure, intellectual property advice and management, and other specialised support.

Technology incubators are often located within technology parks, and many are linked to university centres.[3] Therefore, much of the new technology, and entrepreneurs, may come from that university. These incubators combine the functions of assisting the commercialisation of spin-off technologies with the delivery of a range of state and federally funded industry development programs.

The importance of technology incubation for Australia

Australia is part of a global environment where technologies and markets are both changing rapidly. Technology incubators, especially those located in technology parks, foster the growth of

[3] Technology parks are not the same thing as technology incubators. The former are areas of real estate, often quite large, where groups of companies are co-located together with an array of knowledge-based assets such as research institutions and facilities. The main objective of technology parks is to cultivate technology transfer and promote effective networking between enterprises. Tenant companies are usually focused on one or two industry sectors, and the majority of tenants are commercial entities. Upon graduating from the business incubator, some companies will stay on in the technology park, moving from the incubator to a new location in the park.

entrepreneurial companies that utilise emerging technologies and volatile markets, and create linkages to other companies, including essential knowledge-based assets.

As well as commercialising critical new technology, incubator graduates create many new high value jobs which means major opportunities for revitalising local economies depressed by structural change.

Of the business incubators operating in Australia at present, only around six of these are specifically focused on developing young technology-based companies. These include the incubators located in the Australian Technology Park, Sydney and the Latrobe University Technology Park, Melbourne.

Experience in other countries demonstrates that technology incubators are a very effective way of increasing the number of companies that succeed and grow, and for a relatively modest investment. Scandinavia, Israel and the United States all operate highly successful incubators with a strong technical focus, and these incubators have achieved impressive results. For example, a 1996 survey of US technology incubator managers reported that 90 percent of their graduate companies were still in business.[4] Also, the 450 firms which have graduated to date from the Israeli Technological Incubators program have so far raised a total of $US 200 million in venture capital.

Support in Australia for mechanisms to improve the success rate of entrepreneurial companies is widespread and growing. Equity investors have long reported that they have difficulty finding deals worth investing in as they regard the majority of entrepreneurs as having underdeveloped ideas, poor business planning skills, mediocre management ability, no market research and inflated ideas about the value of their technology. On the other hand, entrepreneurs complain that they have critical innovative technology but there is no early stage capital available in Australia to enable them to commercialise it.

Existing Australian government business assistance programs do not specifically provide for the establishment of technology incubators. Current business incubation programs also have other shortcomings such as being too focused on achieving employment generation objectives rather than growing successful firms, providing inadequate funding support and being based on the misconception that incubators can be independently financially viable.[5] There is clearly a critical gap in the Australia commercialisation market.

A new program based on world best practice with the specific objective of establishing a number of new technology incubators could rapidly increase the amount of successful, technology-based start-up companies in Australia.

What does Australia need to do?

To ensure entrepreneurs in all regions of Australia have access to incubator facilities, the Working Group recommends that approximately 30 new technology incubators be established.

This warrants a significant investment on the part of the Commonwealth Government - an investment of around $50 million per annum over six years would be appropriate to achieve the necessary impact. Existing business incubator managers report that during the crucial feasibility, start-up and further development stages, cash flow and an inadequate capital base can impose

[4] NBIA et al (1997); *Business Incubation Works: The Results of the Impact of Incubator Investments Study*; University Michigan, National Business Incubators Association, Ohio University and Southern Technology Council; August 1997

[5] Overseas and Australian experience suggests that incubators exist in a high state of financial crisis and their failure rate is high. Also, the notion of self-funding incubators appears to be something which is rarely achieved, and then only after several years of loss-making establishment processes.

severe difficulties on incubator operations. Specific problems include having insufficient funds to pay managers, lack of funds for site and building fit-out and development and lack of space.

The level of investment required to establish new technology incubators could be relieved by utilising the vast amount of vacant existing commercial property. Leasing accommodation rather than supplying purpose-built locations, would dramatically reduce incubator start-up costs.

Business incubator managers also report a crucial lack of start-up finance for tenant firms. The Working Group estimates that the Commonwealth Government should provide funding to these new incubators in the order of $200 000 - $300 000 per tenant company. This should be matched partly by funding from the private sector.

Drawing on international best practice, the Working Group believes that to assist the on-going viability of the new incubators, there should be a condition of entry that the potential tenant agree to the incubator taking equity in their company. This would achieve very strong alignment of interests and a focus on rapid growth.