MDL
McKinlay Douglas Ltd

CROWN RESEARCH INSTITUTES

SCIENCE OUTCOMES

A report prepared for the Ministry of Research, Science & Technology

by

McKinlay Douglas Limited

January 2003

36-42 GreySt
P O Box 13 125, Tauranga
Tel: (07) 579 4217 Fax: (07) 579 4218
www.mdl.co.nz
email: mckinlay@mdl.co.nz

Contents

Page

Page

1. INTRODUCTION

This report is the second of two being completed for the Ministry of Research, Science and Technology (MoRST) by McKinlay Douglas Limited (MDL). Its purpose is to act as a think piece on Crown Research Institute (CRI) outcomes, especially commercialisation[1]. The context is MoRST's ongoing work on the recommendations in its recent report *"An Appraisal of Crown Research Institutes 1992-2002"*. Those recommendations were:

- Government must be explicit about its expectations that CRIs focus on the present and future research capability needs of the nation.
- The success of CRIs should be seen by the impacts of their operations on the wider public (social, economic, environmental) good.
- Government should appoint boards with the skill mix appropriate to roles for CRIs that are focused on the wider benefits that their activities deliver to the national innovation system.

The brief for this report, as agreed between MoRST and MDL, is to explore issues including:

- Doing "good science" (linking this outcome to the capability issues in the first paper.)
- Different options for commercialisation including newly-emerging initiatives such as the Australian Institute for Commercialisation as well as the learning available from continuing research on apparently successful models such as Silicon Valley, Route 128 and Cambridge.
- The implications of making further capital available to assist with pre-seed or spin-off funding – an area where the need for combining flexibility on the one hand with controls/processes to protect against new perverse incentives may be particularly important.
- Contribution to wider economic, environmental and social goals.

The overriding purpose of this report is to stimulate discussion of approaches to commercialisation, including access to capital and other resources, that could promote different or complementary strategies to those currently being pursued by government, especially through CRIs and in relation to the research they undertake. This is consistent with the recognition that restoring New Zealand to the top 50% of the OECD in terms of per capita income will be critically dependent on adding value through, amongst other means, the application of research outputs.

As with the companion report *"Crown Research Institutes: Governance and Capability"*, the intention for this report is that MDL's work should seek to raise questions that might

[1] In this report the term 'commercialisation' is used to encompass activities whose purpose is to maximise the full economic return from R & D expenditure. Most often, this will be through processes that are commercial in the sense that they are undertaken by for profit entities with the purpose of generating an economic surplus. However, as used in this report, the term also encompasses processes that exploit research in order to produce improved environmental, social or cultural outcomes for New Zealanders.

not necessarily emerge through the conventional departmental policy process. Essentially, the requirement on MDL is to provide an alternative perspective regarding commercialisation.

We start by describing the approach taken in preparing this report. In the balance of the report we:

- Discuss what could be meant, in New Zealand, by doing "good science".
- Provide an overview of current concerns about translating research outputs into commercially viable innovations.
- Provide some international perspectives on commercialisation.
- Provide some New Zealand perspectives on commercialisation.
- Outline some possible initiatives for improving the commercialisation process.
- Discuss access to capital.
- Consider CRI contributions to wider economic, environmental and social goals.
- Make some concluding comments.

2. APPROACH

In preparing this report we drew, to varying degrees, on:

- Discussions with individuals involved in research within CRIs and with experience in innovation both as managers/owners of innovative firms and as investors.
- Scanned current writings on research and innovation, drawing particularly on material available through the Internet.
- Spoke with officials and others involved in New Zealand's economic development programmes.
- Drew on MDL's own previous research and advisory work on science policy and on economic development.

3. DOING "GOOD SCIENCE"

The question of what doing "good science" means needs to be answered in the context of the role and purpose of Crown Research Institutes, not just from a perspective of science as such.

The CRI Act provides some guidance with the Section 4 requirement that *"The purpose of every Crown Research Institute is to undertake research"* coupled with Section 5's statement of the principles that CRIs should follow in fulfilling that purpose. These include:

- Research undertaken by a Crown Research Institute should be undertaken for the benefit of New Zealand.
- A Crown Research Institute should pursue excellence in all its activities.

The term "benefit of New Zealand" is not defined in the Act nor has government, either as owner of CRIs or as principal funder through the Foundation for Research, Science and Technology (FRST), itself made any definitive statement. Nonetheless, in considering what doing "good science" might mean, the benefit requirement and the associated requirement for excellence in all activities represent as good a starting point as any.

One attempt to define "benefit of New Zealand" is the FRST paper *"National Benefit and its Application to Publicly Funded Research, Science and Technology Investments"*. That paper was prepared from FRST's perspective as purchaser. Its starting point is that its mission *"… is to invest in innovation for New Zealand's future. Research produces new knowledge. Innovation is the **application** of new knowledge."*

Amongst its stated principles are:

- Research goals may be economic, environmental or social. New knowledge underpins each. The Minister determines the broad relative priorities among these goals, through the output classes. The Foundation's task is to design and manage a decision process that balances prospective risks and returns across many science areas in the various output classes so as to generate the maximum benefit to NZ from taxpayers' dollars.
- Knowledge must be potentially useful and eventually be used for benefits to be realised. Capability building must be useful too. It is done to produce deferred benefits.
- Only the benefits and costs that accrue to NZ matter, but foreign companies operating in NZ, overseas commercialisation and international linkages may add net value to NZ.
- Maximising national benefit is not the same as maximising returns to any one stakeholder. The incentives that are given to act in the national interest are crucial.

The theme coming through those principles is that of maximising benefit to New Zealand from the taxpayers' investment. That is, research is not undertaken simply to pursue knowledge for its own sake, but for an instrumental reason – contributing to improved outcomes for New Zealanders.

Further insight is provided in the government's growth and innovation strategy statement *"Growing an Innovative New Zealand"*, the conclusion to which states:

> *"If we are to reverse the declining trend in our relative income measures we must achieve a step change in growth rates.*
>
> *We must become a nation known internationally for our innovation, our creativity, our skills and our lifestyle.*
>
> *To do that government is committing to implementing policies with more emphasis on:*
>
> - *Enhancing our innovation framework.*
> - *Developing our skills and talents.*
> - *Increasing our global connectedness.*
> - *Focusing innovation initiatives in those areas which can have maximum impact.*
>
> *Government has chosen to target its innovation initiatives initially in biotechnology, Information and Communication Technology and the creative industries. These are all areas which, if they attain their growth potential, can have a significant influence on the broad scope of the New Zealand economy. But obviously they cannot achieve the growth required for the whole economy on their own.*
>
> *Innovation must happen across the board. Skills and talents in all areas will be important. We must attract the right sort of foreign direct investment."*

A complementary perspective is found in *"New Zealanders – Innovators to the World: Turning Great Ideas Into Great Ventures: An Innovation Framework for New Zealand"*, the final report of the Science and Innovation Advisory Council, which has this to say:

> ***Create Wealth From Ideas and Knowledge***
>
> *New Zealanders have been good at generating ideas and knowledge but less successful at creating wealth from them. Commercialisation of knowledge and ideas on a global scale is a particular form of entrepreneurship that requires specialist expertise. There are significant risks that need to be carefully managed in order to create wealth from high-value, high-growth innovations. We need to:*
>
> - ***Understand and be able to respond to high-margin global markets**, both current and emerging.*
> - ***Support the companies** that have the potential to achieve substantial growth over the next ten years in high-value goods and services (**high-margin, high-growth ventures**), remove the*

barriers to their growth, and assist them to achieve their potential.

- ***Provide more specialist expertise to help ventures commercialise** innovations for high-value global markets and **access global knowledge and expertise**.*
- ***Stimulate the development of new ventures.***
- *Stimulate the development of commercialisable ideas from our world-class research, **improve the yield from the government's investment in research, science and technology**, and from its investment in economic development.*
- *Ensure we **get most value for our intellectual property**.*
- ***Increase the liquidity and volume of capital** to grow high-value ventures, and assist ventures going global to **manage the distinctive risks** of adopting a 'global leader' strategy."*

The combination of these themes reinforces the view that, from a public policy perspective, good science is science that will contribute to innovation leading to better outcomes for New Zealanders (increased incomes through innovation as research is commercialised; better environmental and social outcomes from an increased understanding of New Zealand's environment and society).

Of the three outcome areas, economic, environmental and social, the material quoted collectively creates a strong sense that the economic outcome is seen as the most significant, perhaps on the view that if we cannot lift New Zealand's rate of growth to a level that places us back in the top half of the OECD, then we will not have the resources we need to address our environmental and social concerns. Whether that balance is the appropriate one is a debate for another occasion.

The second dimension, excellence, is one that has been gaining increased attention within New Zealand, especially in the tertiary sector with the recently published report of the Performance-Based Research Fund Working Group *"Investing in Excellence"*. The executive summary for that report states:

> *"The Working Group concluded that the focus of a PBRF should be on reviewing and rewarding researcher excellence and excellent research, defined in terms of:*
>
> - *Producing and creating leading edge knowledge;*
> - *Applying that knowledge;*
> - *Disseminating that knowledge to students in the wider community; and*
> - *Supporting current and potential colleagues to create, apply and disseminate knowledge."*

Obviously, part of that statement is specific to the role of universities as research-based teaching institutions. However the core components of creating leading edge knowledge, applying that knowledge, disseminating it and supporting colleagues are equally applicable in the CRI sector. This is the case even though, for example, the mode of dissemination may be different – seeking to maximise the gains to New Zealand from

commercialisation, for example, rather than, as in universities, contributing to the public store of knowledge (although even universities, in today's environment, are increasingly focused on gaining a commercial return from research activity where it is possible and appropriate to achieve that).

The Working Group approach is that excellence is to be determined primarily through measures such as peer review and recognition (awards etc) with quantitative metrics such as publication and citation rates seen as secondary largely because of a concern that they provide perverse incentives – encouraging academics to focus on publishing or on placing their names on research undertaken by others (for example on work of supervised postgraduate students) rather than concentrating on research outcomes per se.

In summary, doing "good science" is a combination of doing science that attracts peer recognition and science that generates identifiable benefits for New Zealand. This conclusion is not as neat as it appears. Both recognising excellence and identifying ex-ante the likely level and nature of benefits are fraught with difficulty.

Peer review has been defined as *"a superb system for eliminating the worst 50% and the best 10% of proposals"*. The serious reasoning behind this somewhat flippant definition is that genuine breakthroughs may be outside the comfort zone of peer reviewers who have built their career and recognition within a current paradigm that a different vision may challenge.

Nor is predicting the outcomes of research, especially basic research, straightforward as is highlighted by the following quotation from *"Unlocking Our Future : Toward a New National Science Policy"*, a report to the US Congress by the House Committee on Science:

> *"Investment in basic research involves a willingness to take risks for eventual gain; for every revolutionary discovery there are other lines of research that yield far less momentous results. Such is the nature of basic research. The results carry the potential to lead to important or unexpected advances, but no assurances. Were a particular outcome of any given research project known in advance, the project would not truly be basic in nature.*
>
> *James S. Langer, Professor of Physics at the University of California at Santa Barbara, summed up the essence of this point in an e-mail contribution to this Science Policy Study. "History tells us," he wrote, "that even the greatest scientists could not consistently point out the most profitable directions for research or predict the implications of their own discoveries. Newton spent a large part of his career studying alchemy. Einstein devoted the second half of his life to problems that we now know could not be solved without modern discoveries in elementary-particle physics. Bardeen grossly underestimated the importance of his invention of the transistor, as did most major U.S. industrial corporations at the time…While I am certain that we shall see remarkable scientific advances in the near future, I am equally certain that we cannot trust scientists, engineers, or public policy experts to predict where those advances will occur or in what ways they will have*

their greatest impacts."

A second view can be found in a recently published article *"What's the Use of Basic Science?"* by C H Llewellyn-Smith, the former Director General of CERN[2]:

> *"I have argued that economic, as well as cultural, considerations lead to the conclusion that public funding should be primarily directed to basic, rather than applied, science. If however we appeal to economic arguments in this way, we cannot object to their use in discussions of the partition of funding between different areas of basic science. The problem is that "both forecasting and innovation are highly stochastic processes, so that the probability of correctly forecasting an innovation, being the product of two low probabilities, is, in theory, close to zero."*
>
> *This unpredictability, which I have argued is one reason that it is up to governments to fund basic science in the first place, also means that in practice it is probably impossible, and very possibly dangerous, to try to distribute funding for basic science on the basis of perceived economic utility. The traditional criteria of scientific excellence, and the excellence of the people involved, are probably as good as any, and in my opinion these are the criteria that should continue to be used - after all money is more abundant than brains even in this cost-conscious era."*

In his concluding remarks, the author goes on to note and deplore the changing environment for basic science – from the curiosity driven approach which characterised the decades from 1945[3] to a new emphasis on outcome related investment. He observes:

> *"Now, in virtually all OECD countries, a new social contract for science seems to be emerging. This is exemplified by the UK's white paper, referred to above, and the foresight exercises, which imply that governments will invest in basic research only if it can be shown that it is likely to generate rather direct and specific benefits in the form of wealth creation and improvements of the quality of life.*
>
> *I have argued that this is a bad policy. The demand that basic science should only be funded if the generation of specific benefits can be anticipated is misguided, and may actually be economically counterproductive. However, the tide shows no sign of turning, as indicated by the following quotation from an article published in Research Europe on 5th June of this year:*
>
> 'When the heads of Germany's biggest research organizations took the unprecedented step in January of writing an open letter to the Federal Research Minister virtually calling upon him to do a U-turn, it was not clear what the impact would be. Would Jürgen Rüttgers press ahead

[2] The European Organisation for Nuclear Research.

[3] The date of publication of *"Science – the Endless Frontier"*, the report of a group led by Vannevar Bush, the US Presidential Science Advisor, which set the scene for science policy in countries such as the US and much of Europe until the late 1980s.

> with plans to restrict funding for basic research and channel more money into research targeted on economic priorities, or would he heed the call of Germany's research community and back off? Now the outcome is clear. Rüttgers has not changed course one bit to please the Deutsche Forschungsgemeinschaft and its scientific allies'."

These quotations highlight a dilemma for doing "good science" in the New Zealand environment. Excellence and relevance as criteria for investment in research seem easy to describe but are potentially difficult to apply and, unless used carefully, capable of producing perverse outcomes. The dilemma is particularly acute for New Zealand, and for science undertaken by CRIs, as much of the motivation for both government ownership of CRIs and government funding of CRI research is to compensate for the shortfall in private sector investment, relative to other developed countries. Inevitably, therefore, CRIs are committed not simply to basic research but to a mix of basic and applied research (Lewellyn-Smith himself recognises the term 'strategic research' as sometimes *"… used to describe science in an intermediate category which appears to have a good chance of applications even if it is done to satisfy curiosity, and is leading to new fundamental understandings".*)

This highlights what is, in essence, a challenge for both the boards of CRIs and for FRST – to recognise the basic public policy purpose behind funding CRI research on the one hand but on the other to allow for the inherent risks of trying to constrain curiosity driven research by attempting to determine, in advance, where that should lead.

Managing that challenge requires a clear recognition that CRIs face what are inherently conflicting expectations: that they will continue to be New Zealand's principal institutions for undertaking basic research and that they will be not only commercially successful but major contributors to the application of research for commercial ends. The nature of this dilemma is highlighted by the Frascati definition of research that recognises that *"Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable fact, without any particular application or use in view."*

FRST estimates that, currently, just under 50% of its investment in research and development is in basic research in terms of the Frascati definition. At the same time its mission is to invest in innovation for New Zealand's future, with innovation understood as the application of new knowledge.

The full Frascati definition of research covers three activities: basic research, applied research and experimental development. The latter two are defined as:

- *"Applied research is also original investigation undertaken to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective."*
- *"Experimental development is systematic work, drawing on existing knowledge gained from research and/or practical experience, that is directed to producing new materials, products or devices to installing new processes, systems and services, or to improving substantially those already produced or installed."*

Superficially, the closer a CRI's activities are towards the experimental end of the research spectrum, the greater the probability that commercialisable outcomes can be

identified ex ante. Conversely, the closer to the basic research end of the spectrum, the more difficult it will be to forecast any direct link with expected practical applications.

On the other hand, the closer to the experimental development end of the spectrum, the more a CRI will come to resemble a professional consultancy and the less resemblance it will bear to research institutions engaged in curiosity based research.

The risk for New Zealand if the shift towards the experimental development/professional consultancy end of the spectrum is too great is that New Zealand will lose strengths such as:

- The capability to undertake basic research in areas of particular significance to New Zealand, whether in areas dealing with New Zealand's natural environment or in areas where the country may have a particular comparative advantage (as in parts of the primary sector).
- The significant professional networking and other advantages that come from being part of the international scientific community, something that requires maintaining New Zealand's reputation and activity in original scientific work.
- The environment within which to train and develop scientists with the skills required to meet New Zealand's needs, not just in basic research but in applied research and experimental development.

Thus, setting the framework for doing "good science" requires an ongoing balancing act between:

- Peer review and the dangers of past knowledge limiting future learning.
- Relevance (benefit to New Zealand) and dumbing down science through imposing narrowly specified understandings of what relevance might be.

4. BACKGROUND • A BRIEF OVERVIEW OF CONCERNS ABOUT TRANSFORMING KNOWLEDGE TO INNOVATION

The Science and Innovation Advisory Council report, quoted above, sets out a common view of the New Zealand situation: *"New Zealanders have been good at generating ideas and knowledge but less successful at creating wealth from them"*.

New Zealand is not alone in facing this particular problem. Rather, there is considerable evidence that the problem is generic. In the course of preparing this report, we undertook an extensive scan of international sources, looking for current or recent evidence or comment on the relationship between knowledge and innovation. Specifically, we were seeking material focused on the relationship between those responsible for undertaking research (scientists) and those who might commercialise it (especially private sector firms and potential intermediaries such as financiers).

In February 2002 the UK National Audit Office published *"Delivering the Commercialisation of Public Sector Science"*. It noted that:

> *"The traditional focus in Research Establishments is, rightly, on producing the highest quality scientific research and advice. To meet the increasing emphasis on commercialisation, a culture that is also supportive of commercial activity, which helps staff to overcome barriers, such as the lack of recognition for commercialisation work, is needed. This will require change in many Research Establishments."*

and

> *"Scientists do not generally have business training and cannot be expected routinely to display or to acquire the full range of commercial skills required to commercialise their research."*

A 1999 report *"Commercialisation of University Research in Europe"* prepared for the Expert Panel on the Commercialisation of University Research for the Advisory Council on Science and Technology, Ontario, Canada notes:

> *"Although the picture is changing rapidly, European universities have lagged a long way behind the experience and practices of US academic institutions in terms of industry collaboration and research commercialisation. Much of this has been due to the institutional and legal barriers that have often prohibited academic staff from working directly with industry. Social and cultural attitudes (based on perceptions about what universities' role in society should be) have also strongly militated against direct industry involvement. To some extent, intermediary institutions and agencies have been set up to get around this by providing an interface between universities and industry. However, in a way, this has delayed universities and their staff gaining more direct involvement and experience with industry. This is most evident in the UK, where British universities have, to a*

> *large extent, led Europe in industry/academic relations, but were restricted in their ability to exploit and commercialise their own research outputs because of the monopoly control of this process by BTG up until the mid 1980s."*

European concern over the nature of linkages between academia and industry, and the understandings each sector has of the other, remains strong. The 6 September 2002 issue of *'Next Wave'*, the online journal of science (http://nextwave.sciencemag.org/) carried an article *"Agents for Change: Bringing Industry and Academia Together to Develop Career Opportunities for Young Researchers"* reporting the action plan adopted at a meeting that took place at the Nobel Forum in Stockholm, Sweden, March 2002. The meeting included a group of industry leaders, directors of government funding agencies, heads of European foundations, and presidents and deans of European universities. The concern driving those at the meeting was described in these terms:

> *"Europe's future health and prosperity depend very much on the next generation of researchers. But in meeting after meeting—most recently and perhaps best articulated in Strasbourg at a symposium co-sponsored by the Human Frontiers Science Program and the European Science Foundation—it has been pointed out that Europe's academic system may be failing its young people. Moreover, the links between industry and academia that empower young, entrepreneurially minded researchers in the United States are frequently lacking in Europe."*

Overall, internationally the picture is not entirely different from the New Zealand situation. There is a growing emphasis (driven very substantially by government fiscal concerns) to see a closer linkage between doing research and exploiting the results of research for primarily economic but also environmental and social purposes. At the same time, there are both tensions and misunderstandings obstructing the process of turning knowledge into innovation. Some obstacles are cultural – a still persisting sense that the pursuit of knowledge has value for its own sake. Too often it seems that researchers lack any real understanding of business and that business may lack a sufficient understanding of research and the research environment. Others are structural – a relative lack of the capital markets and other infrastructure needed for effective commercialisation. Yet others are capability gaps – in the skills needed to manage commercialisation or in the absorptive capability within private sector firms.

Attempts to overcome the obstacles of commercialisation are taking place in virtually every developed country, but with a measure of concern that this may carry its own risks. One, clearly, is that attempting to constrain the allocation of resources to research by requiring researchers to specify in advance the outcomes they expect may impact adversely on the best of curiosity driven research to the overall detriment of society. Proponents of this viewpoint to the numerous examples of significant discoveries that no one could have predicted would have emerged from the research concerned.

Even in the United States, recognised as the leading example of close research/industry linkages and effective commercialisation of research, the relationship between knowledge and innovation is still raising concerns, albeit of a somewhat different kind from those just traversed.

First, to quote from a recent address by the President of the Massachusetts Institute of Technology (Vest, 2002):

> *"As the private sector's role in maintaining the health of the US R & D enterprise has been expanding, the Federal Government's contribution has been receding, as the federal share has become less prominent in both the funding and performance of R & D. As a result, the composition of the nation's R & D investment is slowly shifting."*
>
> *"While it is good news that US industrial R & D continues to increase as a percentage of GDP, it remains critically important for the nation that the Federal Government:*
>
> - *Maintain and expand its commitment to frontier research;*
> - *Address the imbalance in the nation's research portfolio; and*
> - *Work hard to stem the declining numbers of graduates in key science and engineering fields that puts at risk the nation's future innovation capability."*

Associated with this is a concern that increased private funding is intensifying the conflict between academic and corporate objectives. Adams et al (2000), in a paper reviewing experience with industry-university cooperative research centres, comment:

> *"The rewards from university research traditionally come from reputation. Reputation promotes mobility and mobility in turn generates salary increases and teaching reduction. Thus the rewards to academic research depend on the dissemination of findings in open science. But the rewards to industrial research derive mostly from corporate profits, and these rely on confidentiality. Hence the coming together of academic and industrial research moves academic research towards secrecy, in conflict with standard academic practice."*

A further concern is the potential for conflict of interest. In June 2001 the Business-Higher Education Forum published *"Working Together, Creating Knowledge: The University-Industry Research Collaboration Initiative"* (www.acenet.edu/bookstore/pdf/working-together.pdf). The San Francisco Chronicle, in an article *"Report Emphases Biotech's Need for Academic-Corporate Study – authors discuss how to continue research, avoid ethical lapses"*, commented on the report's findings, noting:

> *"Written by leading academic, corporate and governmental research officials, the report reinforces the belief that university-industry cosiness has helped the United States retain world leadership in fields such as computing, software, telecommunications and biotechnology. But as ties between the boardroom and the classroom have increased, so have concerns about potential conflicts and instances of outright scandal. In 1998, for instance, corporations provided $2 billion for academic experiments, about 9% of all research funding at US colleges and universities.*
>
> *By no coincidence, by the late 1990s ample evidence was surfacing*

> *that all this corporate cash did not come without consequences. There were scandals involving prominent biomedical researchers, who had financial interests in clinical trials and subjected volunteer patients to risky experiments. More subtle, but no less troublesome, were suggestions that researchers who took corporate funds were more likely to publish good news and suppress bad news from their experiments and put out lower-quality work in general. "Studies suggest that academics with a high proportion of corporate support publish less frequently and produce work that has less impact." said Mildred Cho, a researcher with the Stanford Center for Biomedical Ethics who has studied the effects of corporate funding on universities."*

It is against that background, and its uncertainties, that this report seeks to generate new thinking on how the research/innovation linkage in New Zealand could be strengthened.

From a New Zealand perspective, the most interesting offshore experience comes from Australia. Some two years ago the Queensland Government established, as a Crown-owned company, the Australian Institute for Commercialisation. The AIC's brief is to *"… be the focal point for a national push to deliver enhanced levels of commercialisation benefits from Australia's R & D investment".*

In an address in October 2002 to the AVCC Deputy and Pro-Vice-Chancellors (Research) Committee, Peter Jonson, the Chair of AIC, outlined the work of AIC and commercialisation generally and tabled a set of what he described as "the blockers" to commercialisation. (The full set is attached to this report as Appendix One.)

A number of the factors identified will look very familiar to New Zealand eyes. For example:

> *"Historically Australia has a low tolerance for failure and therefore an inappropriately high aversion to risk, particularly in publicly funded research organisations. We need to encourage wider appreciation of the basic fact that seeking high returns requires risks to be taken and that the failure of some high risk ventures is inevitable."* (In a New Zealand environment, this raises very real questions about the position of ministers as CRI owners – given their political vulnerability, could they tolerate such an approach to risk?)
>
> *"Financiers say there is no shortage of funds for good projects whilst many scientists complain of lack of funds or about the terms on which funds are available. This 'commercialisation chasm' needs to be bridged, and there is a clear facilitation role to be played by governments and organisations such as the AIC."*

5. COMMERCIALISATION • SOME INTERNATIONAL PERSPECTIVES

In this section we look at examples taken from international experience to identify lessons that may be of value in thinking about the commercialisation process in New Zealand. One initial point needs to be made. New Zealand is atypical in the extent to which research is carried out through standalone commercially structured research institutes – Crown Research Institutes – rather than in universities. The difference has significance because the typical approach to the commissioning and managing of research within universities is quite different from what takes place within a Crown Research Institute.

Typically, academics within a university will have a high degree of autonomy in the research they undertake. A professor or other senior academic may typically seek his or her own research funding from grant making bodies and will do so without there necessarily being any overarching university research strategy within which that research might fit.

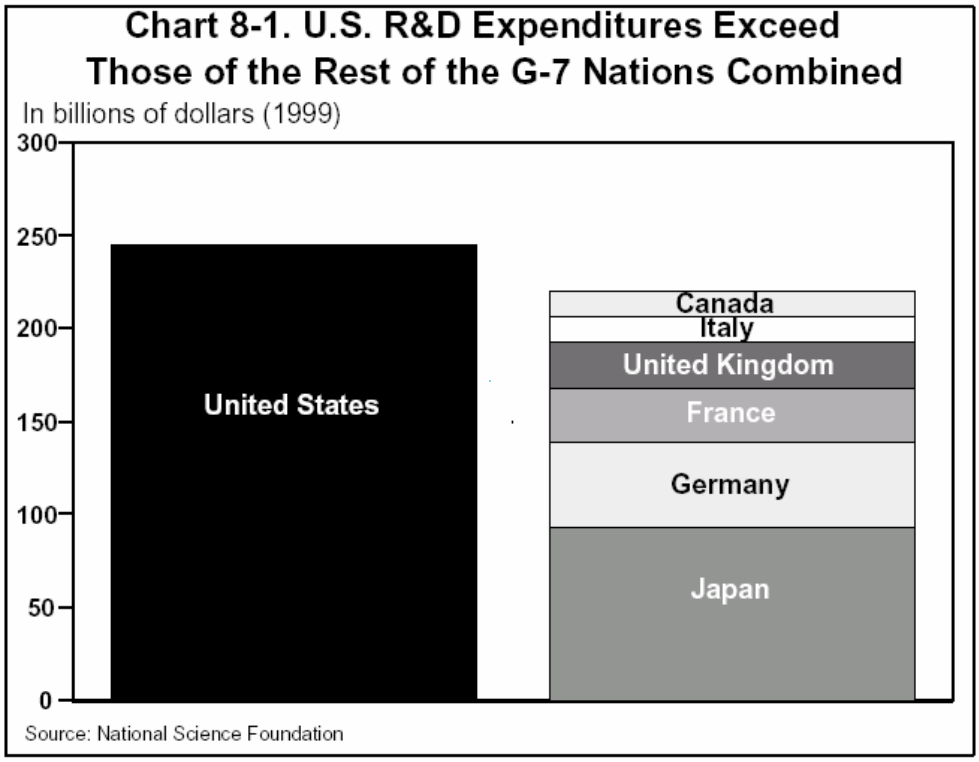
In contrast, within CRIs researchers undertake projects that fit within the CRI's strategic and business plans and will have been signed off on by senior management. Although ideas for research projects may arise at any level within a CRI, responsibility for deciding what activity to undertake is ultimately held at the level of the chief executive.

In New Zealand, that situation will start to change as the performance based research fund approach begins to bite but academic freedom will still remain a powerful force and one peculiar to the university rather than the CRI structure.

In this section we want to look at different approaches to/practices in the commercialisation of research in order to provide a context for those happening or that could happen within New Zealand. We will look at North America, Europe (mainly the UK) and Australia.

In looking at international experience, one thing that stands out is the difference between the United States and other developed countries. There is a very real sense that, in terms of commercialisation, the United States has a qualitatively different situation from the rest of the world. Questions of how to make commercialisation work effectively have moved beyond matters of principle, culture or ideology to issues of application. In contrast, the rest of the world appears still to be working through questions of what will be effective in their own environment and what not, and how to build an effective relationship between the research and business communities.

One reason is the sheer scale of US research and development expenditure, as shown in the table below:



Another factor widely regarded as critical is the so-called Bayh-Dole Act of 1980 that clarified ownership to intellectual property arising out of federally funded research in universities and other not-for-profit institutions. The Act made it clear that entitlement to intellectual property belonged to the research institution but subject to conditions which included what is often referred to as the "use it or lose it" requirement. The research institution must disclose each new invention to the federal funding agency within two months after the inventor discloses it in writing to the research institution and then has two years within which to decide whether or not to retain title. If it decides to, it must file a patent application within one year of doing so.

The legislation is credited with encouraging a major shift in universities in developing the expertise needed for technology transfer and also in providing a strong incentive for university-industry research collaborations. Appendix Two to this paper attaches "*'The Bayh-Dole Act': A Guide to the Law and Implementing Regulations"* published by the Council on Governmental Relations.

Looking at experience elsewhere suggests a combination of a number of matters that have yet to be fully resolved including:

- Culture.
- Capability, especially in the private sector.
- Incentives, especially around ownership of intellectual property.

CULTURE

Developing a culture supportive of commercialisation is still a major issue for many national research systems. In the United Kingdom a number of different sources highlight this. As examples:

- The Spring 2000 workshop of the Research Administrators Group Network (which links together research administrators from universities, other research institutions and government departments) included a presentation *"Commercialisation – Part of the Answer?".* This identified problems including:
  - Commercialisation is low on the academic agenda and their general perception of the entire process is very negative, although they can be persuaded of its merits.
  - Perhaps more importantly, the research assessment exercise (the UK equivalent of the process about to be instituted in New Zealand with the Performance Based Research Fund) did not reward links with industry.
- A Royal Society of Edinburgh seminar in December 1996 noted that:

> *"The research assessment exercise generally rewards excellence in basic research rather than commercialisation activities. If higher education institution departments emphasised the latter they are liable to receive low ratings with consequent loss of funding for their department. Additionally, if top class scientists become entrepreneurs, their contribution to departmental RAE ratings will be lost."*

Formatted: Indent: Left: 0.7 cm, Hanging: 0.63 cm, Bulleted + Level: 1 + Aligned at: 0 cm + Tab after: 0.63 cm + Indent at: 0.63 cm, Tabs: 1.34 cm, List tab + Not at 0.63 cm

The problem of culture in the UK appears not limited to academics but may also be a private sector issue as well. In 1998 the Association for University Research and Industry Links reported that their offices commonly experienced difficulty in attracting UK companies to consider licensable forms of research output (patents, software, etc) whereas Japanese and American companies in particular seem much more aggressive in responding to licensing opportunities. A UK company may still tend to feel that as a taxpayer they are entitled to free or low cost access to such technology.

More recent work suggests that the cultural barrier may be breaking down. A recent OECD report (OECD 2002, p.77) notes that there has been a "culture change" within academic and industry science relationships have become one of the activities considered by academic staff as part of their mission. At the same time it also notes that *"Researchers, academic staff and universities themselves are often confronted with contradictory incentives regarding ISRs."*

Canada reports a much more positive university/industry relationship. A Conference Board of Canada study, *"Paths to Commercialisation of University Research – Collaborative Research"* (Zieminski & Warda, 1999) reports:

> *"Although some university researchers may still view collaboration with the corporate world as a form of an 'intellectual sell-out', today this attitude becomes an exception rather than the norm. Application-oriented and industry driven research is no longer viewed as being*

> *incompatible with the definition of 'quality research'. The presence of collaboration champions and their growing numbers are part and parcel of the changing university culture. These champions are as much a product of this change as they are its originator. The more of them there are, the more pro-collaboration the culture within the university. The more pro-collaborative the culture, the more likely the emergence of additional champions. In fact, individual researchers who responded to our survey viewed collaboration champions as the single most important driver of collaboration."*

This is associated with a change in corporate culture:

> *"Corporate culture has also been changing. A growing body of research in firm-level innovation showed the advantages of networking and collaboration. Today, companies are better aware of this than ever before. They have also become much better at paying attention to and overcoming the 'Not Invented Here' attitude. Similarly, they are more likely than in the past to appreciate the marketing benefits of a well-timed publication of the research results."*

Australia, in contrast, appears to be more akin to the situation recorded in the quotations above regarding the UK situation. The "blockers" identified by the Australian Institute for Commercialisation and set out in Appendix One to this report show that there are still significant cultural barriers to overcome.

CAPABILITY

Capability in the commercialisation of science involves at least two and possibly three sets of actors:

- The research institutions themselves – where capability is concerned with matters such as how they identify (or enable the identification of) potentially commercialisable research, how they manage their intellectual property, and how adept they are at identifying potential partners/users of research and establishing those relationships to the benefit of the institution.
- (Possibly) intermediaries – firms or individuals who are capable of working between research institutions and potential end-users.
- End-users – or rather the end-use environment. What are the characteristics of potential end-use sectors? Do they have the skills, capability and resources required to work with research institutions, identify the potential of the research they have developed, and manage the commercialisation process? Does the end-use sector include needed capabilities in accessing finance, markets, and managing the commercialisation process, including the development of the innovation itself to a commercially viable stage?

For the United States, the answer would seem generally to be yes on all three dimensions. There are still debates about how effective aspects of the US commercialisation process have been (for example, how successful has MIT really been in

generating spin-outs and what value have they added) but generally the US seems very well placed in relation to the rest of the developed world.

In the United Kingdom there is evidence of very significant developments in areas such as university industry research collaborations. Calvert and Patel (2002) report that there has been a rapid increase in the volume of university-industry collaborations since the 1980s and that, between the early 1980s and the late 1990s, joint university-industry papers increased from about a quarter to around half of all industrial scientific output.

Perhaps of some concern, depending on the perspective taken on national benefit, they also report that foreign firms are the dominant collaborators with UK universities in the electrical and electronics industries and are also significant in the chemicals, scientific instruments and automobiles industries. As well, they report that the largest volume of collaborative activity, in terms of joint papers, is with the pharmaceuticals industry. Most of this, in UK terms, is foreign controlled.

This latter finding is consistent with the OECD Science, Technology and Industry Scoreboard 2001, which records that *"Foreign ownership of domestic inventions is high in several small OECD countries, but also in Canada and the United Kingdom, where US companies own a large share of inventions"*.

Indictors such as the rising level of university-industry collaboration and the growth in the number of professional research administrators in the university sector (see www.ragnet.ac.uk) suggests increasing capability in the United Kingdom. On the other hand, there may be still ground for concern about the capability of the end-user sector – private firms and supporting infrastructure – in its capability to exploit effectively the findings of research (especially in the "national benefit" sense discussed above).

Athreye (2001) considers the growth of the Cambridge high technology cluster and similarities to and differences with Silicon Valley, especially the failure of Cambridge to globalise to the same degree.

The paper is an important one because of the prominence that the Cambridge high tech cluster has had in thinking about the potential of research to develop significant spin-off activities. Athreye notes that in Cambridge there is an incredibly high rate of technology transfer in the form of entrepreneurial high technology start-ups but this has been accompanied by somewhat muted growth because of a singular absence of large scale product markets that would go with that technology transfer. Indeed, it may even be a Cambridge spin to an old cliché about Britain: it is good at invention but not innovation.

In his conclusions, he observes that:

> *"While it is certainly true that most Cambridge firms export, they have not created global markets that rely on their exports alone. Put differently, the leading firms of the early 80s did not capture global markets in any one product/technology space. There were at least two reasons why it did not happen. First, they were unable to cope with the competition from US firms when, after all, the largest market for their products was in the US. Second, the lack of good marketing and management skills, which seemed to be endemic to the growth of*

British industry."

Accepting that the comments on marketing and management may be somewhat harsh, the point is nonetheless relevant for New Zealand. If you do not have world class management and marketing skills, or world scale industries in the areas in which you are seeking to innovate, how sensible is it to try and create the industry against inherently stronger competition? Does this suggest that the quite strong emphasis, for example in FRST's definition of national benefit, to commercialisation by New Zealand owned firms needs to be subject to quite a strong caveat?

A further point of interest from Athreye's paper is the significant role played in the development of the Cambridge high tech cluster of a handful of significant individuals. In both IT and biotechnology, two or three individuals are identified as making up the nodes in a network of relationships that were responsible for much of the growth of the cluster.

Again, there is an interesting parallel with the New Zealand situation. Work undertaken by the New Zealand Institute of Economic Research for the Wellington City Council to identify the comparative advantages that Wellington had as a location for the development of the film industry concluded that there was really only one – that Peter Jackson wanted to live and work in Wellington.

Canadian work on commercialisation puts particular emphasis on the skills required to manage the process of commercialisation. The proceedings of the Federal Partners in Technology Transfer Workshop *"Skills Development for Technology Commercialisation"* (www.fptt-pftt.gc.ca/proceedings00/2000Proceedings.html) identified a number of key factors. Among them were:

- A technology transfer or business development officer is a necessary link between the industry and technology communities, hence it is necessary for him/her to possess a diverse set of skills in order to survive and to strive on this interface.
- The job of a technology transfer officer is comparable to someone standing in a lake with one foot in a business boat and the other foot in a science boat.
- Technology transfer is "a contact sport" and the skills are only sharpened with experience. In order to learn about technology transfer, the best way is to get in there, find the mentor networks and skills training, and just do it!
- Technology transfer officers should "add their value or step aside," meaning that they must step back when they are not needed to mediate between science and business parties.
- Successful technology transfer requires a combination of a good technology, someone who wants it, and a technology transfer professional who can put the deal together and finalise it.
- The reality of getting technology successfully out of the lab into products is primarily a function of entrepreneurism. The "three Rs of commercialisation" should be kept in mind: risk, reward, and resources.
- During the commercialisation stage, it is crucial to remember that in a good company, there is good feedback from the market.

- The generation of companies is easy, it is making them work that is more difficult and requires the investment of time and money.
- The top three growth factors for an SME are: strategic partners; seed capital; and management skills.
- Companies that go through a formalised incubation period process are four times more likely to succeed in business within a five-year period than those that don't.
- Learn from failure; research managers must accept the fact that they might fail.
- Be wary of "due diligence paralysis" because the containment of all the risks is not a guarantee, therefore, gut instincts must be trusted.

Here, the Canadians are following well-established US practice of placing great stress on the role of technology transfer professionals – people who work within the research institution and who collectively, as a technology transfer team, have high level expertise in the research areas in which the institution is engaged, in the management of intellectual property, and in working with the commercial sector.

The point that *"the generation of companies is easy, it is making them work that is more difficult and requires the investment of time and money"* is also extremely important. Internationally (and in New Zealand) there is a growing interest in the use of spin-off companies as a means of commercialising research when the existing private sector environment lacks the skills or the interest required. The Canadian workshop is emphasising a point of crucial significance: the mere creation of a spin-off company as a legal structure does nothing, of itself, to fill the skills gap or transform a research finding into a highly successful commercial product or service. Ultimately, what is needed is real people with real skills and experience.

A recent report (Yencken & Gillin, 2002) identifies a recent and significant improvement in performance in generating new spin-off ventures amongst best performing Australian universities, but notes that the bulk of the sector, including medium and smaller research universities and public sector research organisations such as CSIRO, are still significantly behind and facing what the paper describes as *"a harder task because of their recent low scale of new venture generation"*.

As in New Zealand, the Australian Federal Government, and various state governments, are active in seeking to encourage innovation – for example, see *"Backing Australia's Ability – An Innovation Action Plan for the Future"*. It is described as:

> *"A commitment to pursue excellence in research, science and technology, to build an even more highly skilled workforce and increase opportunities for the commercialisation of new ideas – in essence it is about backing Australia's ability."*

One of the inputs into that policy statement was the Australian Chief Scientist's discussion paper *"The Chance to Change"*. The recommendations in the paper are not markedly different from much of what has been considered in New Zealand – developing stronger guidelines on commercialisation, encouraging greater SME access, establishing innovation centres to provide universities and government funded research agencies with

support in commercialising research, establishing a pre-seed capital fund, reviewing opportunities for researchers to get a share in the benefits of commercialisation, and adopting a more strategic approach to the management of intellectual property.

The public picture of the approach to commercialisation of research in Australia is one of significant and apparently well directed activity. Whether it is proving successful or targeting what needs to be targeted may be less clear.

As part of the research for this paper, we spoke with the Acting Chief Executive of the Australian Institute for Commercialisation. He identified a number of problems including:

- The role of the private sector.
- The failure of researchers to put forward strong value propositions to potential investors.
- Lack of performance by publicly funded research institutions (he described the CSIRO as the worst commercialiser of research in Australia).

In respect of the private sector, he thought that too many industry people were inclined to see research and development expenditure, venture investments, etc as almost like giving money away to the Salvation Army. As he saw it, even in cooperative research consortia, industry people do not have the time or commitment and if the firm does take it up, responsibility is likely to be delegated well beneath a level of authority needed to commit resources.

He was also somewhat sceptical about the emphasis on spin-off companies. In his view the jury is still out on whether they are a critical component of the commercialisation process or just a fad following on from the dot.com enthusiasm of the 1990s.

INCENTIVES

The major incentive issue this section considers is the sharing of the gains from the commercialisation of intellectual property. Practice world wide differs quite considerably as to views on how best to create incentives.

We have already seen that in the United States the Bayh-Dole Act establishes a legal framework for dealing with intellectual property that results from federally funded research. That framework includes a requirement for universities to have in place a policy for sharing returns with inventors. Different universities take different approaches. As examples:

- Western Michigan University's policy is that any royalties derived from patents from activity involving the use of significant university space or equipment shall be shared equally with the University and the inventor.
- The University of Wisconsin-Madison policy is that *"Except as required by funding agreements or other University policies, the University does not claim ownership rights in the intellectual property generated during research by its faculty, staff or students."*

- Stanford University policy is that royalties will be distributed first by a deduction of 15% to cover the administrative overhead of the University's Office of Technology licensing and secondly, after deducting any other expenses, equally amongst the inventor, the inventor's department and the inventor's school.[4]

Despite the widely differing policies on the distribution of royalty income within universities in the United States, the research for this paper did not turn up any evidence of significant discontent or instability. This probably reflects the fact that American universities have been engaged in active management of intellectual property much longer than universities in any other developed country. Differences in approach are no doubt well understood in the academic marketplace and simply reflect one of the factors that research staff will take into account when looking at options for employment.

The situation is much different in other jurisdictions. The UK, Canada and Australia are still working through the question of what type of incentive arrangements should be in place, what purpose they are intended to serve, and what impact they may have in practice. There does seem to be widespread agreement on one point: although academic staff may be primarily interested in research and publication for its own sake, they also have a quite strong interest in financial reward. Thus

- *"Managing and Commercialising Intellectual Property – A Guide For Victorian Universities and Research Institutes",* a discussion document released by the Victorian Minister for Innovation in October 2002, notes that:

  > *"Despite the common perception that academics are not interested in money, a recent study of the views and attitudes of academics towards IP policy issues revealed that approximately 80% regarded personal financial rewards as important. The survey did also reveal, however, that the majority regards the right to personal financial rewards as secondary in importance to the right to publish."*

- *"Delivering the Commercialisation of Public Sector Science"* a report released in February 2002 by the UK National Audit Office, emphasises the importance of encouraging scientists to engage actively in commercialisation and goes on to report:

  > *"Our survey indicated, however, that this is frequently not done. There is often a perceived conflict between the confidentiality required by commercial activity and the desire to publish research results, on which the performance assessments of scientists are largely based. Our survey also indicated that scientists did not see financial incentives as a main motivating factor. But there is anecdotal evidence from many of those who participated in this study that visible evidence of the positive impact of incentives on colleagues did change attitudes. The impact of the awards to inventors schemes and the scope for staff to act as company founders were thought to be particularly important. A recent innovative example comes from the Human Reproductive Science Unit where a number of scientists have been given the opportunity to take equity stakes in a spin-out company specialising in women's health and this, in conjunction with the input of market knowledge from the*

Formatted: Indent: Left: 0.13 cm, Bulleted + Level: 1 + Aligned at: 0 cm + Tab after: 0.7 cm + Indent at: 0.7 cm, Tabs: Not at 0.7 cm

[4] Massachusetts Institute of Technology applies basically the same policy.

> *private sector, is linked to an upsurge in commercial activity. It appears, therefore, that scientists' involvement can be stimulated and rewarded through the provision of fair and effective incentives."*

Practice diverges quite widely. Two of Canada's leading research universities illustrate the difference.

University of British Colombia

The University reserves the right to ownership of intellectual property from research carried out at the university. After the recovery of direct licensing costs, any royalties are divided 50% to the inventor, 25% to the inventor's faculty and 25% to the University's general purpose operating fund.

The University is regarded as one of the most efficient generators of spin-off companies – with a success rate in the order of one spin-off for each US$40 million in research funding, a rate significantly better than the US median.

University of Waterloo

At this university, researchers are able to retain ownership of the technologies they develop. The University's Office of Research's policies and procedures statement commences *"The University of Waterloo has traditionally encouraged the existence of an entrepreneurial environment at the University by permitting the researchers to retain ownership of technologies they develop."* The University does, however, maintain within its Technology Transfer and Licensing Office, a variety of services to assist in the pursuit of commercialisation opportunities.

Its success has been described as *"The University's commitment to technology transfer is evident in the fact that the University is a Canadian leader in contract research, as well as royalty and license revenues from technology transfer."* (www.techtriangle.com\ english\workforce.html).

A 1999 report, *"Public Investments in University Research: Reaping the Benefits"* prepared by an expert panel for the Canadian Prime Minister's Advisory Council on Science and Technology is in no doubt as to which is the better approach. It is forceful in its condemnation of the policy of vesting ownership of intellectual property in researchers.

> *"The absence of a coherent national policy on IP ownership and disclosure in Canada is resulting in the immediate loss of commercialization opportunities, leaked benefits to other countries, costly litigation, and is limiting the longer-term innovative potential of Canadian firms.*
>
> ***Lost Commercialization Opportunities***
>
> *The Panel believes that vesting IP ownership with university researchers is one of the single biggest factors accounting for lost commercialization opportunities in Canada. Since most university discoveries involve multiple researchers, this approach has resulted in*

much co-ownership of IP in Canada. This is making it very difficult to negotiate licensing agreements with established firms. Under a co-ownership model, it is equally difficult to entice risk capital providers and skilled managers to support the establishment of spin-off companies."

"Immediate benefits to Canada are also lost when researchers with IP ownership entitlement are simply not interested in exploring commercial opportunities. Indeed, most researchers are far more interested in pursuing science-based discoveries than using their scarcest of commodities – time – to write business plans, draft legal technology transfer agreements and the like. Since researchers are often not required to disclose their IP to universities, it is impossible to know how many good opportunities are presently being lost.

Leaked Benefits
While many of the university researchers that do commercialize their IP generate benefits to the nation, it is not reasonable to assume that they all act in the national interest. The Panel is aware of many cases where Canadian researchers created IP with public funds, entered into consulting contracts with U.S. firms, and were handsomely rewarded through consulting fees in return for assigning away IP rights. This is how Canada lost the jobs and investments that it was entitled to expect from its investment in therapeutics research. Although most of the research was funded by Canada, all manufacturing and value added from this global industry is taking place outside the country."

The Victorian report referred to above (p.23) endorses the Canadian approach and, in discussion of incentives, prefers the UK approach set out in a July 2000 publication of the Office of Science and Technology *"Good Practice for Public Sector Research Establishments on Staff Incentives and the Management of Conflicts of Interest"*. Again, that statement recognises the importance of incentives, stating that:

If PSREs[5] are to increase the rate at which they exploit their research outputs, they must develop a culture in which knowledge transfer is valued more highly than at present. The culture in research establishments has been to value the excellence of research almost exclusively, and to reflect this in the rewards available to scientific staff. The culture should now value not only the scientific excellence of research but also the impact it makes on the nation's prosperity and quality of life. One way to achieve this culture change is to provide staff with incentives which encourage them to maximise the economic potential of their research."

One important good practice feature it identifies is designing schemes so that researchers receive a high proportion of initial income and a lower proportion thereafter. Benefits claimed for this include:

[5] A PSRE is a Public Sector Research Establishment.

- Providing encouragement for researchers to pursue commercialisation of even relatively small-scale projects.
- Giving early recognition rather than waiting until royalty flows have paid off commercialisation costs.

One example of the sliding scale approach is the University of Cambridge policy on sharing net benefits:

Net Income	*Inventor (%)*	*Department (%)*	*University (%)*
First £20,000	90%	5%	5%
Next £40,000	70%	15%	15%
Next £40,000	50%	25%	25%
Above £100,000	33.3%	33.3%	33.3%

SUMMARY

Generally, what emerges from reviewing international material on commercialisation is that:

- Successful commercialisation is far more important for the contribution that it makes to economic, social and environmental outcomes within any given society than it is for the royalty contribution it makes to the research institution.
- Good industry science relationships are essential and include not just formalised structures or arrangements for information sharing but informal structures and networks based on a genuine ability for each sector to understand what drives the other.
- Effective commercialisation is dependent on dedicated expertise. The best examples of commercialisation from a research institution basis have very well established qualified and experienced technology transfer officers who have significant industry standing and expertise, good networks, and a high level of capability.
- Establishing appropriate incentives for research staff is important – both to encourage them to identify potentially commercialisable research and to gain their commitment to the commercialisation process (often including a self-denial requirement as far as normal research returns such as the right to publish are concerned).
- Ensuring that research staff themselves have a clear understanding of the intellectual property process is an essential part of securing the potential gains from commercialisation (including, for example, the importance of documenting the research process and avoiding premature disclosure).

- Design of incentive schemes is important as is the ownership of the right to commercialise the research. (In this respect the Canadian view on ownership of intellectual property may be focusing on the wrong variable. What is crucial is that the right to develop the intellectual property is vested in an entity that has the necessary capability and appropriate incentives.)

- Private sector capability is crucial. This encompasses not just the capability to understand and incorporate research findings within private sector activities, but the marketing and management skills needed to operate effectively in a global environment (or alternatively the means of accessing those) as well as capital markets and other services attuned to the needs of commercialisation within the institutional and cultural framework of the country concerned.

6. COMMERCIALISATION • SOME NEW ZEALAND PERSPECTIVES

INTRODUCTION

In this section we look at commercialisation in the New Zealand context under the three headings of:

- Informant observations.
- International Comparisons.
- Financial and Management Considerations.

We conclude this section with a review of obstacles and opportunities.

INFORMANT OBSERVATIONS

At the risk of generalising, virtually all informants consulted in the preparation of this report in one way or another drew a distinction between land-based CRIs and others when considering commercialisation. In broad terms, the land-based CRIs were seen as either actually or potentially the research arm of existing and substantial industry groupings or firms with much of the capability needed to manage commercialisation.

As with any generalisation, a number of qualifications are needed. As examples:

- In some sectors, overseas control may limit local decision making and, possibly, the ability for New Zealand to gain the full benefit from research. FRI is the obvious example with the extent of overseas control of New Zealand's forest resources. Do overseas owners want added value activity in New Zealand or will they prefer to see it as a source of raw material?
- The relationship between a CRI and a dominant industry player may not always be an easy one. The dairy industry provides an example.
- Some CRI/industry relationships have not been as well managed as might be desired. The recent history of HortResearch provides an example, but a new and apparently very positive emphasis on establishing industry partnerships appears to be turning this around.

Other CRIs are seen as being in a somewhat different situation – working in areas where, so far as commercialisation is concerned, New Zealand has far less capability (in the sense of industry skills and experience, marketing and management expertise, and access to/ownership of distribution channels).

One informant, recognised as being very knowledgeable about the New Zealand innovation system, was particularly forceful in his comments. As he put it, he had a suspicion that a lot of things that people like IRL are doing are really just paying for the lifestyles of the scientists. The real question for the science system is how to get people

engaged in work that produces value. He doubts that research institutes are being rigorous enough in looking for commercialisable research.

In support of this comment, he quoted IRL's involvement in superconductivity research. There was (and is) no company in New Zealand capable of picking it up. Effectively the New Zealand taxpayer has been subsidising the research and development requirements of a major American corporate.

For this informant, the answer was that the commercialisation focus needs to come much earlier in the investment process. Effectively, what he was saying was that it is no good waiting until you are well down the research track before starting to think about how to commercialise the research outputs.

He noted that this is easier said than done and then commented that much of the success of the research/commercialisation process in the United States had come from directing substantial research expenditure in areas where they know that there are existing industries capable of picking up commercialisable outputs. (One qualification on that approach needs to be noted. This is a very broad-based approach possible because of both the scope and the depth of American industry.)

An alternative view came from someone familiar with IRL. If there are not yet the industries in place to commercialise the outcomes of CRI research, then the job is to create them. It is this philosophy that lies behind the growing interest in spin-off companies, with a CRI using its skills, balance sheet strength, and available external resources for that purpose.

A third perspective comes from the chief executive of another CRI. In his view, CRIs are quite well placed to carry work forward to the proof of concept stage. The difficulty they then face in the commercialisation process is the cost of moving to the next stage, for example, building a prototype. In his experience, attracting significant commercial interest really requires taking this further step beyond proof of concept but CRIs are not well resourced to do this. They do not have either the balance sheet strength or the revenue to allow this. (To do so would require CRIs to have the capability and authority to invest in a portfolio of projects, any one of which might involve up to $0.5-1.0 million to take something through from proof of concept to early stage commercial. The capital requirements would be significant and the revenue implications, in the short term, would almost certainly result in a breach of the financial viability requirement in the CRI Act as currently drafted.)

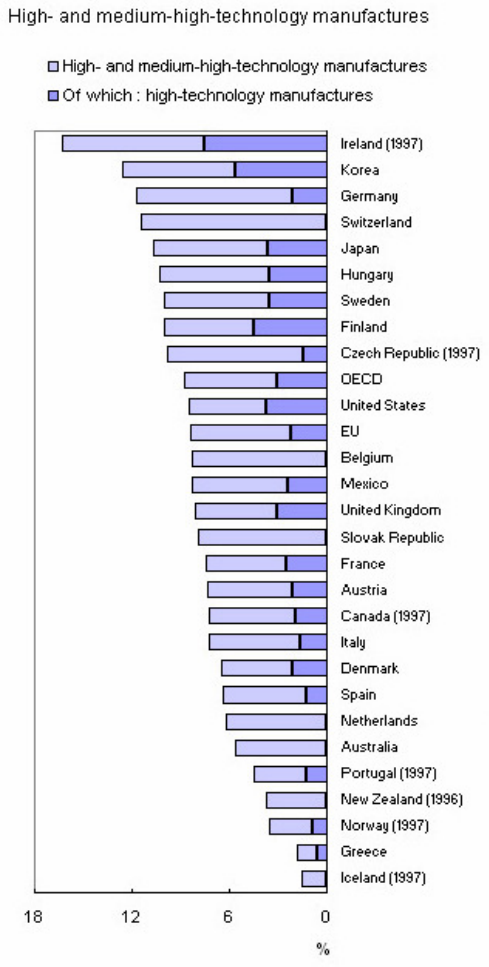
These three perspectives highlight the issue that New Zealand faces in looking at commercialisation of research outputs. The CRI Act emphasis is on research for the benefit of New Zealand. The FRST interpretation is that this requires, if at all possible, that commercialisation should be undertaken by a competent New Zealand firm.

INTERNATIONAL COMPARISONS

This view of the purpose of publicly funded research is a commonly held one. The Canadian report cited above, as an example, is quite forthright in its view that the main goal of the actions it proposes for commercialisation of research "*… is to increase wealth*

creation in Canada; it is not primarily to produce new revenue streams for universities". The New Zealand government clearly has the same goal.

The achievement of this goal is complicated by the structure of the New Zealand economy. Most discussions of research and development in New Zealand highlight the fact that, as a percentage of GDP, our expenditure on research and development is low by OECD standards. Implicit in that assessment is that we are comparing like with like. The reality is that the structure of the New Zealand economy is somewhat less sophisticated than many others in the OECD. The following table, taken from the OECD Science Technology and Innovation Scorecard report for 2001 shows the percentage of GDP generated by high and medium-high technology manufacturers:



New Zealand is well below the OECD average for medium-high technology manufactures and not represented at all in high technology.

Since it is high technology manufactures such as pharmaceuticals and ICT that generate the highest percentages of research and development, it is not surprising that research and development in New Zealand as a percentage of GDP is low. In many respects we

are a branch office economy with much of the research and development for major firms being undertaken offshore. In parallel with this, our major industries – in the primary sector – are in a sector that traditionally invests much less of its turnover (in the order of 1%).

The table may also help explain another feature of the New Zealand environment that we share with Australia. This is the relative lack of technological literacy in our private sector. The structure of our economy is such that we appear to have a relatively low number of people with high level technological skills, at least in management positions in the private sector.

The issue here is the question of absorptive capacity – the ability of private firms to understand and adopt emerging technologies. We can see the relative strength of our absorptive capacity as a function of potentially having the right firms but those firms having the wrong people. Alternatively, we can see it as a function of the fact that our firms themselves are not engaged in areas that make them natural adopters/developers of new technology.

Again, it needs to be noted that these comments are in the nature of generalisations. Clearly we have exceptions in areas such as some parts of the primary sector, with its emphasis on value-added products, and we have had notable, if small-scale, successes in ICT and creative industries.

The three perspectives considered above focus on one of the critical issues for commercialisation of research – what should New Zealand's policy be in commercialising research outputs in areas where New Zealand does not have existing world scale or world connected industries or firms? The argument against trying to create industries where we do not have them is that we may be starting at a disadvantage. We would be seeking to enter industries/markets where other countries will have a competitive advantage based on existing industry capability including distribution channels and supply networks that newly emerging firms in New Zealand might find it hard to build or replicate. On the other hand, if we conclude that New Zealand should avoid commercialising research outputs in areas where it does not already have an existing industry capability, then we may be at risk of restricting New Zealand to its current industry structure – essentially a commodity based, primary sector driven economy.

The Canadian report cited above also addresses this issue, but in the context of the rather greater capacity within the Canadian economy (as reflected in its somewhat higher standing in the OECD table above). The report's suggested approach to dealing with the set of issues just discussed is expressed in the following terms:

> *"It would be best if Canadian companies had the capacity to receive and make good use of all research-based innovations that come out of the universities. The benefit to Canada would come in obvious ways from the success of these companies. The Canadian receptor capacity is substantial, but not as extensive as it needs to be.*
>
> *One way of increasing that capacity is to create spin-off companies to exploit university discoveries. That is being done with remarkable success in many cases, but more needs to be done.*

However, in some markets it may not be practical to create Canadian spin-offs. Some technologies might best be brought to market through multinational enterprises that have Canadian operations. In such cases, negotiations to use IP to create a world product mandate for the Canadian operation would be a good outcome for Canada. At the very least, a significant number of value-added jobs based on the innovation should be created in Canada.

Benefit to Canada can also result if the IP attracts new foreign direct investment (FDI) to Canada. Federal and provincial governments have programs in place to attract FDI, and they should be called on for assistance.

One of the least desirable options is to license IP to a foreign company, with all the jobs and profits realized outside Canada, and to receive only a flow of licence revenue in return – if the licensee, in fact, decides to market the technology."

FINANCIAL AND MANAGEMENT CONSIDERATIONS

This does make a case for an increased emphasis on what is becoming an important strategy for New Zealand's CRIs – the creation of spin-off companies. However this raises its own issues in a New Zealand environment. Creating successful spin-off companies requires access to critical resources including:

- Competent management and marketing skills (note the comment above that the relative absence of these may be one of the explanations for the slow growth of the Cambridge technology cluster).
- Access to appropriate sources of capital to support growth.

One former CRI CEO with experience of spin-off companies put particular stress on this last point. The process of attracting capital for technology development needs to have a clear exit path and liquidity at each stage – pre-seed, seed, early venture, late venture and commercial operation. In his view there were problems at each of these stages in the New Zealand capital market, especially around exit. Here the concern is the thinness of the market – can an investor have confidence that, in two, three or five years time there will be sufficient depth in the market to allow for a profitable exit if the firm has achieved its intended target at that stage?

These concerns raise issues both of scale and of expertise. On scale, one matter raised with us was the size of the various private sector managed investment funds that will operate under the umbrella of the government's venture initiative fund. Will they have sufficient scale that they can afford to employ appropriately qualified and experienced industry specialists? A further issue with the venture investment fund itself is the wisdom of imposing specific timeframes or rules around exit. This was seen as potentially a very real negative, creating the possibility of forced exit rather than allowing the timing of exit to be fixed to optimise the return on investment.

The question of expertise is going to be a significant one as CRIs consider how best to be involved in commercialisation of their research outputs. The overseas material we have reviewed universally emphasises the importance of highly qualified and experienced technology transfer expertise within the research institution itself. This is important not just for the technical business of managing intellectual property but also for the ability to identify potentially commercialisable research, support the researchers involved, and build the necessary connections between them and commercialisation including assisting in judgements about how best to proceed to commercialisation.

Such skills are rare in New Zealand. Currently, virtually every CRI is seeking, apparently without success, to recruit people with those skills to assist them in managing the commercialisation process. This may reflect a more generic issue which will need to be addressed if New Zealand's capability in commercialising research outputs is to improve. This is the relative absence of people with a mix of commercial skills and technological understanding. Interestingly, this was also identified as a problem in the Australian environment in our discussions with the Australian Institute of Commercialisation.

For New Zealand this was highlighted by one informant with significant venture capital industry experience in commenting on the problem with access to capital in New Zealand. He saw this as not so much venture capital as the capital required when a firm was at the stage of scaling up production, essentially as the last point before a listing or trade sale. In this informant's view, this was the critical gap in the New Zealand capital market and it was primarily a consequence of the absence of competent financial analysts who also had the necessary technological understanding – in other words the ability to act as an effective bridge between technology intensive start-up firms and investors.

To put it another way, this informant's view was that the capital was available in New Zealand to meet the gap between venture funding and an ultimate listing or trade sale. It was not being made available because of the lack of the necessary professional skills to act as a bridge between companies seeking that type of funding and investors (primarily institutional) who were the logical providers.

An alternative perspective was provided by another informant who had some years experience working as a senior investment advisor with a major New Zealand institution. In his view the argument just traversed was quite wrong. The real issue from an institutional perspective was a combination of scale and transaction costs. Investigating and, after providing capital, managing an investment of this type was simply uneconomic in a New Zealand context. The opportunities likely to be available and the potential return on investment were simply insufficient to justify the dedicated and costly management time that would be required. This type of institutional investment was perfectly feasible in the US situation where the amount involved might be in the order of US$50-100 million, but not feasible in New Zealand where the amount required was likelier to be in the low single millions or less.

Another informant, also with significant experience in venture capital and with a very good knowledge of current government policy and of key target areas such as ICT, took a different tack. He thought that, except for the land-based industries, New Zealand does not have the firms capable of making use of fundamental research. Instead, our research need is really for advanced development and we may not even have the

industrial base for that. He queried whether the country should be putting significant dollars into areas where it does not have the firms to take up the research outcomes. From this perspective, part of the issue here was that New Zealand does not have enough mid-sized firms that are growing and thus hungry for research and development.

From his perspective, the New Zealand problem can be seen as not so much one of lack of innovation but rather lack of firm expansion. One obstacle he identified is the qualitative shift required in the depth and breadth of management skill as firms grow, a shift that New Zealand was not well placed to meet (an echo here of the comment reported earlier that one reason for the failure of the Cambridge technology cluster to grow to world scale was the relative lack of management and marketing skill within British industry).

OBSTACLES AND OPPORTUNITIES

These various comments identify a range of issues that can be seen as barriers to effective take up of research and development outputs (at least outside the land-based industries). They include:

- A lack of absorptive capability – we lack firms with the capability to commercialise research and development outputs.
- Potentially, a significant problem of performance amongst SMEs – insufficient mid-sized firms that are growing and thus hungry for research and development.
- Capital markets shortcomings including (possibly) lack of industry specific technical capability amongst venture capital firms, perverse incentives in the structure of the venture investment fund (at least regarding exit) and the lack of capital at the post-venture but pre-listing stage.
- The structure of the New Zealand economy itself, with its relatively low presence in high and medium-high technology manufactures.

One possible solution that is clearly attracting attention as a means of commercialisation is for CRIs themselves to play a stronger role. IRL has sought to do so with the evolution of its spin-off strategy (for a recent overview of this see Davenport & Ors, 2001). AgResearch provides another example with its subsidiary, Celentis. This was established as a specialist commercialisation arm with a range of functions including incubating new ventures and investing directly in science including organising the financing of science from research to commercialisation. This is an approach that reflects the view reported earlier (from an IRL related informant) that if a CRI produces research outputs in an area where there were simply not the businesses capable of commercialising innovations, part of its role was to create the industry itself.

This highlights another dilemma. CRIs may appear to be the most appropriate candidates to undertake commercialisation of their research findings if there are not competent New Zealand firms capable of doing so (we should remember that, from a New Zealand perspective, the principal gains from research driven innovation are not royalties or licensing fees but the additional employment and economic activity generated through retaining the businesses that develop and take the innovations to market).

Commercialisation through a CRI may look like the least bad option if the alternative is for New Zealand innovations to be exploited offshore (creating the potential, as with the way one informant described New Zealand's investment in superconductivity research, of the outcome being the New Zealand taxpayer subsidising the research and development costs of an American company).

On the other hand, commercialisation through CRIs themselves raises a number of concerns. These include:

- CRIs are government owned entities. Their significant investment and other decisions normally require political sign-off. This may be inconsistent with the requirement to operate commercially both because of the time taken to get decisions and because non-commercial considerations may play an important role.
- The commercialisation process is inherently high risk. In the commercial world it is common for the risk to be managed by taking a portfolio approach so that returns, overall, may meet or exceed target requirements even though individual investments within the portfolio may result in a total loss. Ministers of the Crown, as shareholders, are risk averse. Would they be prepared (and would the political process allow them) to stand behind a commercialisation strategy, especially if the inevitable losses came early rather than later in the process?
- CRIs themselves lack many of the capabilities required for commercialisation including the management, marketing and industrial or other process skills needed to take an innovation to market.

Despite these obstacles, it seems clear that CRIs will play an increasingly prominent role in commercialisation of research findings (as will universities in terms of the research they undertake) unless and until a sufficient private sector capability develops. The question that we turn to in the next section is thus not so much one of excluding CRIs from playing a role in commercialisation as one of how best to enable it in ways that can best overcome the obstacles identified.

7. POSSIBLE INITIATIVES FOR IMPROVING THE COMMERCIALISATION PROCESS

In this section we canvass some possibilities for improving the commercialisation process, dealing with these under three separate headings:

- Intellectual property.
- Crown Research Institutes.
- Private sector.

We then conclude by offering a different perspective on how to develop a pro-commercialisation environment.

INTELLECTUAL PROPERTY

Entitlement to intellectual property from government funded research in New Zealand has been controversial, especially in projects that have involved private sector partners. Overseas reports on the ownership and management of intellectual property resulting from government funded research (especially the Canadian and Victorian reports first cited at pages 11 and 23 respectively) make a strong case for establishing a regime that:

- Clarifies ownership of intellectual property.
- Seeks to ensure that ownership is vested in an entity or entities that will manage it in a way that optimises national benefit.
- Provides incentives designed to encourage researchers to seek commercialisable outcomes from their research.

The international benchmark for such a regime is the US Bayh-Dole Act with its "use it or lose it" approach (see Appendix Two).

In Australia, the Australian Institute for Commercialisation is advocating a variation on this theme – what its Chairman describes as "Use it or use it". In a recent address (Jonson, 2002) he outlined this concept as follows:

> *"The base idea is this. Every publicly funded scientific research institute would be encouraged/required to assess each piece of patentable research on a regular basis. I envisage this to be a governing board responsibility.*
>
> *The Board would be encouraged/required to make one of four decisions:*
>
> - ***Continue with the research** despite there being no clear pathway to commercial outcomes, as the research has **large potential public benefit.***

- ***'Use it …',*** *because, in the Board's opinion, the research is likely to lead to* ***major commercial success.*** *Each "Use it" research program would be subject to regular reports to some appropriate regulatory authority – eg the Australian Research Council (ARC) – with audited results.*
- ***' … use it',*** *in cases where the institution did* ***not*** *wish to use the patentable idea it would be required to at least apply for a provisional patent and then* ***seek bids for the right to commercialise*** *the idea. Institutions would be required to choose a commercial partner from those competing, with a bias to maximising the potential upside, eg by taking an equity position in a company, or equivalent. Once again, decisions would need to be reported and results tracked.*
- ***Or, fourthly, close the line of enquiry*** *on the grounds it was unlikely to produce serious public benefit or commercial success.*

Whichever decision was taken, the research institution and the regulatory authority would be required to track the progress of each project until some appropriate end point – clear public good or commercial success, project abandoned or put on hold – with the decision backed by good scientific/commercial logic."

The essential difference between Bayh-Dole and the Australian proposal is where the obligation to promote commercialisation lies if the research institution itself does not wish to take responsibility for commercialisation. In the US, the rights of ownership revert to the funding agency. Under the Australian proposal, responsibility remains with the research institution but subject to accountability (presumably to the funding agency).

On balance, the Australian approach looks more attractive in a New Zealand context. Adopting the US approach would require the establishment of a specific function at the funding level, with responsibility for seeking prospective commercial partners to develop intellectual property that the research institution itself did not wish to exploit. Amongst other things this would require people working within the new function to liaise on a regular basis with New Zealand's research institutions and familiarise themselves with the details of the intellectual property concerned. Given the relative shortage of people with technology transfer capabilities, it may prove difficult to staff and manage such a function effectively (especially as, in logic, it should encompass all publicly funded research, including work done by CRIs, universities, research associations, and other entities using public funds).

Even in the US there is reason to believe that federal funding agencies are not always effective in discharging their responsibilities, especially in ensuring that inventions from federally funded research are reported (see Valoir, 2000)

CROWN RESEARCH INSTITUTES

If Crown Research Institutes are to play a major role in commercialising the research that they undertake, then there are a number of areas where useful initiatives could be considered. These include:

- Governance.
- Financial viability.
- Technology transfer capability.
- Contestable funding.

Governance

In the companion report, *"Crown Research Institutes : Governance and Capability"* we highlighted the importance of ensuring that CRI boards were made up of people who, collectively, had the skills, attributes and experience required to enable CRIs to play a central role in the national innovation strategy. We also stressed the importance of building capability.

Those comments were in the context of the role of CRIs in building New Zealand's research and development capability. They are equally valid in the commercialisation role. If CRIs are to play a major role in commercialisation of their research, then their boards will require skills appropriate to the management of what would amount to a major incubator/start-up/spin-off role. This is partly a matter of selecting appropriate people for board membership. It is also partly ensuring that their skills are further developed, where necessary, to fulfil the intended role. We note with interest the approach being taken by the Australian Institute of Commercialisation to raise the capability not just of directors but also of commercialisation staff. Jonson (2002) highlights two initiatives:

- With the Australian Institute of Company Directors, and with input from the venture capital community, the AIC will be running a "postgraduate" course on the challenges and pitfalls of being a director of start-up companies.
- The AIC will also be running a series of "boot camps" for commercialisation staff of cooperative research centres (CRCs) and universities, with input from several leading business schools and the venture capital community.

There may be merit in considering a similar initiative in New Zealand targeted not just to directors of CRIs and their commercialisation staff, but to directors in equivalent organisations (for example, the commercialisation arm of universities) and people who might become directors of spin-off companies or CRI subsidiaries. Alternatively, the AIC might be prepared to accept New Zealand candidates in its programmes.

There is a further governance issue that should be dealt with if CRIs are to be effective in commercialisation. This is ensuring that CRIs not only have the formal powers to act commercially, but that they also operate in a decision-making framework that recognises commercial reality. Currently it can take many months (sometimes longer) for CRIs to gain approval to significant business initiatives that may require a ministerial or other

government sign off or a response to a request for additional capital. Delays of this type are simply inappropriate for organisations that are expected to act commercially, especially in an environment in which they are seeking to engage commercial partners who have alternatives.

Financial Viability

If CRIs are to play a major role in commercialisation, then they need to operate within a financial framework that recognises the nature of the investment process involved in commercialising research. Typically, this requires the ability to invest today for returns in two, three or perhaps five years time. The financial viability test contained in Section 5 of the Crown Research Institutes Act is inconsistent with this. Effectively, it requires CRIs to concentrate on delivering short-term financial returns.

The discipline of being required to earn (target) a commercial rate of return is entirely appropriate for an organisation engaged in commercialising research. The issue that needs to be addressed is the timeframe. The test should be redefined so that CRIs and shareholding ministers can agree strategic and business plans that focus on returns to the shareholder over a multi-year period rather than on returns year by year.

Technology Transfer Capability

English, Canadian, American and Australian experiences all emphasise the critical role of the technology transfer professional in commercialising research carried out by universities and other public research institutions. In the US, the passage of the Bayh-Dole Act was itself sufficient to trigger the emergence of the technology transfer professional as a key player in the commercialisation process. In this respect, the US appears unique. In the UK, Canada and Australia, the emergence of a strong technology transfer capability seems to have been (and still to be) a much slower process. This may reflect factors such as:

- The greater depth of the US market.
- The much stronger tradition in the US of people moving between academic institutions, government and the private sector.

In New Zealand there seems to be a particular shortage of people with the mix of skills required. Informants for this report commented on:

- The shortage of people combining the skills of financial analysts with a strong technological understanding.
- The risk that the funds being established under the venture initiative fund will be of insufficient scale to employ (develop) sector specific skills.
- The fact that virtually all CRIs are trying, without success, to recruit individuals with this mix of skills and experience.

The issue is common to CRIs and universities. Both need people with these skills if New Zealand is to gain full benefit from their research activities[6]. Rather than individual research institutions competing against each other in the market to try and recruit people who may have the necessary skills, there would be merit in New Zealand's research institutions combining to offer incentives and training opportunities to encourage people to pursue a career in technology transfer. Although this is of obvious interest to government, rather than seeking to direct how the country's research institutions should go about this, it should be signalling in general terms (through letters of expectation, statements of corporate intent, and other documents of accountability) its expectation that research institutions should give the development of a cadre of technology transfer professionals a high priority.

Contestable Funding

One issue faced by CRIs seeking to commercialise research is the cost of moving from proof of concept to pre-commercial development. This will often require the development of a prototype or other substantial investment to allow actual testing of the concept and its refinement to a point at which an informed judgement can be made on its commercial potential.

CRIs have very limited ability to fund this type of activity from capital or retained earnings. Reasons include:

- Under the current balance sheet regime they have limited scope to deploy capital for development purposes.
- Much of this cost would be expensed rather than capitalised, thus making it more difficult for them to satisfy the current financial viability test (and meet earnings targets set in their statements of corporate intent).
- Ideally, CRIs should take a portfolio approach rather than seek to pick a single winner from amongst potential projects, thus increasing their need for capital.

In theory, CRIs have the ability to put a business case to shareholding ministers for an increase in capital if they require further funds for investment/development. In practice, that can be very difficult to achieve (and in fact has not yet been achieved by any CRI) because of the government's reluctance to subscribe for further capital.

A possible alternative would be the establishment of a contestable fund available to CRIs (and possibly universities) as a source of funding for pre-commercial development. Funding would be allocated on the quality of the business plan including the assessment of the research itself, the market opportunity, and the CRI's demonstrated capability to carry the project through to the point at which commercial funding could realistically be sought. Funding should be provided on the basis that it was repayable from proceeds of commercialisation with the Crown entitled to share in any super profits arising from particularly successful innovations.

[6] Even if commercialisation is undertaken mainly by private sector parties, specialist technology transfer skills in our research institutions are an essential element in the process of identifying commercialisable research and optimising returns.

The question of access to capital, generally, is considered in a separate section below.

PRIVATE SECTOR

There are no "magic bullet" answers to the question of how better to equip New Zealand's private sector so that it has the capability to commercialise the research outputs from New Zealand's research institutions. Desirably, some of the initiatives already discussed, such as the development of a cadre of technology transfer officers within research institutions, would improve the rate of uptake. In practice, it is likely that any improvement in the capability of the New Zealand private sector to commercialise research outcomes will result from a number of different factors such as:

- The emergence of directors and management with a greater level of technological literacy and with management and marketing skills that are internationally competitive. (This comment begs the question of how that will happen.)
- A shift in the investment patterns and practices of New Zealand investors. It is noteworthy, for example, that New Zealand has one of the lowest ratios of sharemarket capitalisation to GDP of any developed country.
- A greater willingness on the part of financial institutions to invest in the pre-commercial stage of start-up development. In MDL's opinion, the view that the cost of assessing such investment opportunities and then monitoring any investments that may be made is disproportionate to the potential return is a very real obstacle.

There is one initiative we have encountered that does seem to have considerable merit. This is the strategy that has been adopted by UTEK Corporation, a Florida-based corporation that describes itself as *"a business development company that acquires, develops and finances university technology for its corporate customers".*

UTEK acts as a bridge between university research and technology companies with the capability of commercialising that research. It employs individuals with high level qualifications and experience in financial analysis, business development and technology. It uses a scientific advisory council to assess technologies that it offers for commercialisation.

The typical approach followed by UTEK when it identifies a technology that it believes is appropriate for commercialisation is to establish a separate portfolio company and acquire, from the university, a world-wide license for exploitation of the technology. On occasions, UTEK, through the portfolio company, will advance funds to the university for the further development of the innovation.

UTEK then seeks out a company to take over the further development and commercialisation of the innovation. That company acquires the majority of shares in the portfolio company, with UTEK continuing to hold a minority.

Under this model, each party benefits:

- The university receives 100% of the royalty stream with no deductions for UTEK or any other party.

- The company that acts as the commercialiser acquires the right to do so at no cost other than a commitment to commercialise.
- UTEK gets its reward from its continued minority shareholding in the portfolio company.

UTEK's target market is companies with a market capitalisation of less than US$250 million. Its assessment is that companies at or below that level of market capitalisation will typically lack the in-house capability to undertake and manage their own research and development programmes.

The model appears attractive to research institutions, not just in the US but elsewhere. As an example, in August 2002 the University of York entered into an alliance agreement with UTEK to facilitate bringing select University of York technologies to the market place. York joined Loughborough University and Warwick University as UK university alliance partners of UTEK.

On the basis of the material that MDL has seen, the UTEK model looks to be an extremely promising one and worth further investigation. The one cautionary comment we would make is that the relative scale of the New Zealand market may mean that the model would be less effective, at least if it was seen as designed primarily to transfer technology to existing New Zealand firms (in a parallel with the transaction costs problem New Zealand institutions have with investing in pre-commercial development).

A DIFFERENT PERSPECTIVE

The primary reason why governments have an interest in the commercialisation of research was well stated in the report of the Canadian expert panel on the commercialisation of university research as to *"… increase wealth creation in Canada: it is not primarily to produce new revenue streams for the universities."* The same goal clearly drives New Zealand government policy. Commercialisation of research is seen as an important means of lifting New Zealand's growth rate.

The end is clear. The New Zealand government wishes to see annual economic growth of at least 4% in order to restore New Zealand's per capita income to the top half of OECD rankings. It has determined that achieving this requires lifting New Zealand's capability and performance as an exporter of high value added goods and services. For that process to add wealth to New Zealand rather than to other countries, at the very least those firms and their activities must be wholly or partly domiciled in New Zealand and the intellectual property developed here.

Against this background, an emphasis on improving our performance in the commercialisation of research can be seen as a preferred means of realising the intermediate goal of developing high performing New Zealand domiciled (and owned) exporters of value added goods and services.

The material traversed in this report dealing with the commercialisation process raises a number of question marks about how effective it actually is. Is there really a linear process of a kind that involves selecting research projects, undertaking research,

assessing the research outcomes, protecting intellectual property and then commercialising that in a way that results in the growth of locally owned, high performing firms? Much of the material reviewed in this report would suggest that the linkages are still very difficult to establish. The only economy in which it can be said with any substantial degree of confidence that this process appears to work effectively is the US and its success may be a combination of unique features including:

- The scale of US research expenditure.
- The depth and breadth of its private sector capability.
- The nature and flexibility of its capital markets.
- Its depth of internationally competitive marketing and management skills.

A different way of looking at the question of how best to encourage the emergence of high performing, export oriented firms is to start asking the question "What kind of environment is required to encourage the establishment or location of firms of the desired characteristics?" The heavy emphasis on commercialisation policy can be seen as reflecting an approach to economic development that assumes the key factor is the firm's location decision. From this, it follows that the appropriate strategy is to make the environment as attractive as possible, part of which includes ensuring the presence of a strong research base relevant to the type of firms sought.

An alternative view of the location process is emerging from the work of researchers such as Richard Florida, Professor of Regional Economic Development at Carnegie Mellon University. In a recent book (Florida, 2002a) and in an article written to publicise the book itself (Florida, 2002b), he makes the case that the key location decisions are now taken not by firms but by individuals. His research shows that, increasingly, members of the "creative class" make location decisions based on lifestyle opportunities rather than because of a decision to work for a specific employer. They expect – and their experience has generally been – that they will find adequate employment opportunities in the location they choose as the place where they wish to live.

Florida goes on to describe what this means for localities themselves seeking to be well positioned for growth:

> *"How do you build a truly creative community – one that can survive and prosper in this emerging age? The key can no longer be found in the usual strategies. Recruiting more companies won't do it; neither will trying to become the next Silicon Valley. While it certainly remains important to have a solid business climate, having an effective people climate is even more essential. By this I mean a general strategy aimed at attracting and retaining people – especially, but not limited to, creative people. This entails remaining open to diversity and actively working to cultivate it, and investing in the lifestyle amenities that people really want and use often, as opposed to using financial incentives to attract companies, build professional sports stadiums, or develop retail complexes."*

Support for this analysis comes from the business community. At a meeting of the US National Governors Association in 2000, Carly Fiorina, the CEO of (then) Hewlett Packard, stated:

> *"We don't want your tax incentives. We don't want your highway interchanges. We don't want more of this physical infrastructure. We will go where the highly skilled people are. Governors, give us more of them."*

It is a reasonable judgement that the effective commercialisation of the research outputs of New Zealand's research institutions (and for that matter, maintaining/enhancing New Zealand's research capabilities) is dependent on the type of highly skilled people who make up Richard Florida's creative class. The various initiatives that have been reviewed in this paper can be seen as, indirectly, different and possibly sub-optimal attempts to attract and retain highly skilled people – whether it is technology transfer experts, financial analysts with strong technological skills, internationally competitive marketing or management professionals, and so on. The material reviewed for this report, and the informants interviewed, suggest that we have not been particularly successful.

Is there an argument that, in terms of building the kind of commercialisation/innovation environment we want, we have been targeting the wrong objectives? Would it make better sense for government and others to shift their focus to creating the kind of environment in which the people we need would want to live, work and play? We know that most if not all of these are people who have a high level of international mobility. If lifestyle opportunities are a principal influence on their decisions about where they wish to locate, should we be concentrating our initiatives on creating those lifestyle opportunities – the cultural, recreational and physical settings that would make New Zealand a premium location rather than (or perhaps as well as) looking at further initiatives for investment in encouragement of commercialisation of research? Would we be better to invest in creating the climate in which artists, writers, performing artists and others would wish to be? If we can do this, and create the type of urban environments that are complementary to that, could we then safely leave it to the market (to the choices of individuals and firms) to solve the commercialisation challenge we face?

8. ACCESS TO CAPITAL

This report has already commented on concerns about access to capital, including:

- The difficulties that CRIs have in obtaining capital from their owners, or from retained funds, for development purposes.
- The reluctance of New Zealand institutions to invest in pre-commercial development.

In this part of the report there are two specific matters on which we wish to comment. These are:

- The role of the government as owner.
- The logic of the capital markets strategy being adopted within the national innovation strategy.

GOVERNMENT AS OWNER

Successive New Zealand governments have proven very reluctant to provide further capital to companies they own. Instead, they have typically sought to extract the maximum possible cash from those companies by requiring them to adopt debt : equity structures that leave them relatively fully geared taking into account the nature of the risks in the business and the assets that the business holds.

In MDL's view, shareholding ministers need to consider whether this conservative approach to further investment is consistent with the role they may want CRIs to play in the national innovation strategy. If they want (or expect) CRIs to play a significant role in the commercialisation of research, then they need to consider what this means in terms of access to capital (and, as commented above, how and over what period they set rate of return requirements).

The problem for shareholding ministers is that they do not have available to them a market-based means for assessing any request for further capital investment. They can certainly take advice on the quality of the business plan and of the underlying research, but at the end of the day they are being asked to make a judgement on information that has not been tested in the market. This may be particularly difficult when the critical issues that need to be assessed require scientific or other knowledge that may not be directly held either by ministers or by their advisors.

In this situation, reluctance to provide further capital is understandable. On the other hand, it is also a potentially direct negation of any role CRIs might have as significant commercialisers of research. If they cannot access capital, or if the process of doing so is so long and drawn out as to be non-commercial, then their ability to act as commercialisers may be severely inhibited.

The conventional reaction to this type of problem, at least from a market-based approach, is to see it as a reason why the companies concerned should not be

government owned. In reality, privatisation of CRIs is not on the agenda so this solution is not available.

There are other possibilities. Two worth considering are:

- Setting aside a capped sum to be available for further capital investment in CRIs.
- Adopting a more arm's length but still publicly owned structure.

On the first approach, shareholding ministers (with the support of the Minister of Finance) might have access to a limited fund from which to make further investment in CRI equity where business cases satisfied stated criteria. Expectation and practice should be that requests meeting the stated criteria would be accepted. This could be developed as an evolutionary approach, with the fund being topped up from time to time provided that the government's investment experience was seen as satisfactory. Amongst other things, it would require ministers to display a degree of fortitude when dealing with the inevitable criticism from the occasional apparent failure of an individual commercialisation project (apparent as 'failure' may be no more than that a promising innovation, despite best efforts, for one reason or another did not achieve the hoped for outcome).

Another option would be to transfer the ownership of CRIs to a separate foundation or similar structure and empower that foundation to use its ownership interest in CRIs as a basis for further capital raising. Although there are some superficial attractions with this approach, the risk with it is that it might, in practice, turn out simply to be a more complex version of the same problem. As foundation directors would still be government appointees and accountable to government, a structure of this kind might simply become a further complication within the current bureaucratic ownership process.

CAPITAL MARKETS AND THE NATIONAL INNOVATION STRATEGY

The national innovation strategy has, as one objective, restoring New Zealand's per capita income to the upper half of OECD rankings. Doing so will require New Zealand's growth rate to average at least 4% per annum.

The national innovation strategy vision is of this being achieved through the development of a number of high growth, export oriented companies that are strongly research based. The expectation is that these will come principally from start-up companies or rapid expansion of existing SMEs. In either case, the expectation is that they will require significant capital investment over and above the personal resources of their original owners. The establishment of the government's venture initiative fund, and the various private sector funds that will operate under that, is part of government's strategy for ensuring that these companies will be able to obtain the capital they require.

In conventional capital markets terms, this is a very standard approach. Companies require different kinds of funding at different stages, and this will be provided by different types of investors who themselves have different risk preferences and different skills etc to offer. Typically, venture capital funds will make their investment after the company has used pre-seed funding and the venture capital fund itself will be succeeded by

institutional funds to pre-commercial stage and finally by either a trade sale or an initial public offering (public listing) providing an exit for earlier investors.

What seems not to have been thought through are the implications inherent in that capital markets model. Venture capitalists and/or pre-commercial funders will want to withdraw part or all of their funding at about the time the company is really starting to prove its performance. If it is export oriented, it will have started the process of developing markets and establishing its brand or brands internationally. Almost inevitably, it will be operating in a market or markets that are dominated by much larger offshore firms who have far better access to relevant distribution channels and other support than either the new firm or any potential New Zealand owner of that firm.

Accordingly, the risk in the conventional capital markets model is that, just as the high performing firm is about to realise its potential, its ownership will be made contestable in an environment in which, almost inevitably, the firm will have greater value to an offshore owner than to a New Zealand owner – simply because the offshore owner will be better placed to exploit its potential.

This is a possibly critical issue for the national innovation strategy. Conceptually, dealing with it requires the development of funding (particularly equity) strategies that do not put the ownership of the firm at risk while it is still at the early stages of commercial development. This may require the development of quite non-conventional approaches to investment. Elaboration of this is outside the scope of the current report – our purpose has simply been to highlight the issue.

Finally, we note that the risk will obviously vary depending on the nature of the firm and of its critical assets. The Christchurch IT cluster provides a good example of a group of firms that have passed into overseas ownership but remain domiciled in New Zealand and have grown significantly after the ownership changed hands. The main motivation for the new owner was to acquire access to a skill base that wanted to remain in New Zealand. However, in the absence of that type of critical factor, it is more likely that firms, once acquired, will be shifted offshore – to bring production, research, marketing and other key functions alongside the acquirer.

9. CRI CONTRIBUTIONS TO WIDER ECONOMIC, ENVIRONMENTAL AND SOCIAL GOALS

One of the three recommendation in MoRST's recent report *"An Appraisal of Crown Research Institutes 1992-2002"* was that:

> *"The success of CRIs should be seen by the impacts of their operations on the wider public (social, economic, environmental) good."*

In support of that recommendation the report states:

> *"This means that CRI success is measured across all the principles laid out in the CRI Act. A focus on outcomes delivered means that astute financial management and performance of the companies is being delivered to make a difference, and is not merely an end in itself. It may, for example, demand a range of different approaches to the way government invests in CRIs as well as the ways in which CRIs themselves structure their activities to ensure that a broad range of technology transfer vehicles are operating in the wider economy."*

The comment on investment is a critical one. CRIs finance their activity by selling services (to FRST and others), by drawing on their NSOF funding (on average about 5% of their revenue), and by employing their capital (although that, generally, is committed to supporting their contracted research activity including providing the capital equipment needed for that purpose).

Government, both as owner and as a major purchaser of CRI outputs, has the scope to influence CRI activity to focus on broader societal outcomes through means such as:

- Allocating funding to output classes so that FRST's purchasing activity itself supports those broader outcomes. An example of this is the current FRST RFP for sustainable development.
- Its instruments of governance such as letters of expectation and statements of corporate intent.

At the same time, a measure of care is needed. CRIs are companies and, as such, operate within a very deeply entrenched legal and cultural framework (the impact of much of which is discussed in the companion paper *"Crown Research Institutes: Governance and Capability"*).

There is a parallel in this recommendation with the interest in stakeholder theory – that companies should serve the interests not just of their owners but of other stakeholders such as employees, customers, suppliers and the wider public impacted by the activities of the company.

Michael Jensen (Jensen, 2001) argues that:

> *"Since it is logically impossible to maximise in more than one dimension, purposeful behaviour requires a single valued objective function. 200 years of work in economics and finance implies that in the absence of externalities and monopoly (and when all goods are priced), social welfare is maximised when each firm in an economy maximises its total market value."*

He rejects stakeholder theory as such, arguing that it leaves managers with no guidance on how to make the trade-offs between competing interests but then goes on to argue that:

> *"Creating value takes more than acceptance of value maximisation as the organisational objective. As a statement of corporate purpose or vision, value maximisation is not likely to tap into the energy and enthusiasm of employees and managers to create value. Seen in this light, change in long term market value becomes the scorecard that managers, directors and others use to assess success or failure of the organisation. The choice of value maximisation as the corporate scorecard must be complemented by a corporate vision, strategy and tactics that unite participants in the organisation in its struggle for dominance in its competitive arena."*

In other words, value maximisation is the objective but that objective can only be achieved by ensuring that the organisation operates in such a way that the interests of other stakeholders are respected.

The Economist for 4 January 2003 carries an invited article by Jeffrey Garten, Dean of the Yale School of Management, on business leadership. The purpose of the article is to consider the demands facing corporate leaders, and corporate governance, in the post-9/11, post-Enron era. He argues that the times call for more attention to building great institutions and in respect of the role of the corporation, goes on to comment:

> *"Another aspect of building institutions concerns the role of the corporation in society. Is its goal primarily and exclusively to enrich its shareholders now? Or is its purpose broader – to create value by also enriching employees, customers, suppliers and the communities in which it operates? The 1980s and '90s were about short-term performance, judged narrowly by quarterly targets. In the years ahead, society will be looking to companies to have a broader focus on all stakeholders."*

The challenge for government (and MoRST) in developing means for implementing the second recommendation in the appraisal report is to find means of doing so that are consistent both with the objective of the recommendation and with the legal and financial obligations of CRI boards. This suggests that, generally, CRIs should not be treated any differently than other government owned companies. In other words, if government requires social, environmental or cultural outcomes from CRI activity, then either:

- Funding for that is part of the purchase arrangements between CRIs and FRST; or

- The required conduct is part of a general "good practice" approach that government seeks from all of its companies.

This latter approach could, for example, see government requiring its companies to report on a triple bottom line basis (as Landcare Research already does). It might also lead to government revisiting provisions of the Companies Act such as Section 131, with its requirement that *"a director of a company, when exercising powers or performing duties, must act in good faith and in what the director believes to be the best interests of the company".* Currently that provision is interpreted so that the best interests of the company equate to value maximisation. It would be possible for government to amend that section to provide guidance on the expression "best interests of the company" in a way that, for example, was consistent with Michael Jensen's views on value maximisation.

In summary, the options that MDL would suggest be considered as government looks at implementing the recommendation are:

- Primarily, through ensuring that FRST's purchase policies are supportive of that recommendation.
- Use of instruments of governance but not so as to be in conflict with the expectations that government has of directors regarding return on assets and equity.
- Introducing standard "good practice" requirements for the operation of all Crown owned companies.
- Possibly, amending Section 131 of the Companies Act to align the expression "best interests of the company" with an approach to value maximisation that recognises the importance of respecting other stakeholder interests.

Initiatives of this type could be accompanied by ensuring that there were in place adequate training opportunities for CRI (and possibly other) directors to help them understand government's wider objectives and how they can be reconciled with its commercial objectives.

10. CONCLUDING REMARKS

The purpose of this report has been to provide an overview of aspects of commercialisation drawing on both New Zealand and international experience of and perspectives on commercialisation.

If one consistent theme has emerged it is that there is no "magic bullet" answer to the question of how best to commercialise the outputs of research institutions. Even in the United States where success appears to have been greatest, there are lingering doubts about whether their approach is optimal.

Another point that emerges quite strongly is that New Zealand does have some significant disadvantages in seeking to commercialise research findings including:

- A relative lack of private sector absorptive capacity (with the main exception being within sectors of land-based industry).
- A relative lack of scale, especially in capital markets.
- A relatively unsophisticated economic structure.
- A low proportion of SMEs that are in growth mode and hungry for research and development.

In each of these respects there are strong parallels with the challenges facing Australia in commercialising research and development. This became very clear in discussion with the Acting Chief Executive of the Australian Institute of Commercialisation, who identified many of the same problems facing New Zealand as problems facing Australia. Paradoxically, one benefit from this may be an incentive for New Zealand and Australia to work more closely together in commercialisation of research outputs (something that is already starting to happen as the result of recently established contact between the Australian Institute of Commercialisation and New Zealand agencies such as Industry New Zealand and Trade New Zealand).

Despite (or perhaps because of) the difficulties New Zealand appears to face, there do appear to be a number of initiatives worth considering. These include:

- Putting in place a clear and consistent regime for the management of intellectual property developed through publicly funded research. The Bayh-Dole approach of the US provides a good benchmark. The variation suggested by the Australian Institute of Commercialisation, "Use it or use it", represents a potential improvement, especially through placing the primary responsibility on research institutions, with accountability back to funders, rather than leaving it to funders themselves. There would also be merit in harmonising Australian and New Zealand practice to facilitate understanding by potential developers.
- Development of a cadre of technology transfer specialists. Despite the fact that, in some respects, they are competitors, there would be merit in CRIs and universities working jointly to create a common programme and set of incentives for this purpose.

- If CRIs are to play a significant role in commercialisation, then government should ensure that their governance arrangements are consistent with the need to act commercially.

- Additional funding options should be explored. Possibilities include:

  - A contestable fund available to CRIs (and universities?) to fund prototype or other pre-commercial development on conditions that ensured the Crown participated in any returns including super profits.

  - Possibly a capped fund for providing additional equity to CRIs. Criteria should be clear and established in advance so that CRIs could have confidence that a good business case for additional equity would be successful.

  - The financial viability provisions of the CRI Act should be revisited so that shareholder returns could be targeted over a multi-year period, thus making it easier for CRIs to invest in commercialisation.

Formatted: Indent: Left: 0.7 cm, Hanging: 0.63 cm, Bulleted + Level: 1 + Aligned at: 0 cm + Tab after: 0.63 cm + Indent at: 0.63 cm, Tabs: 1.34 cm, List tab + Not at 0.63 cm

It is difficult to propose specific private sector focused initiatives that would pass a standard public policy test. There is too much of a risk that government initiatives to encourage greater private sector involvement might simply worsen an already difficult situation. However, there are areas where there is a clear need and where the private sector itself might be able to take the initiative. One is seeking to ensure that company boards and senior management do have a greater level of technological literacy. (It is important to recognise here that one reason for the apparently low level of technological literacy in many New Zealand companies is that this suits the nature of their businesses. They may not require a great level of technological sophistication. They may be, and often are, branch offices of multi-national firms that undertake their research and development elsewhere.)

One possibility that should be explored is the type of educational and development initiatives being undertaken by the Australian Institute of Commercialisation. Separate programmes could be established in New Zealand but there would be merit in seeing whether the AIC programmes could be open to New Zealand candidates.

One very promising initiative that merits further investigation is the technology transfer business of UTEK Corporation. On the face of it, this looks to be a very promising way of marrying research institutions and potential commercialisers of that research who themselves lack sufficient internal research and development capability to go it alone.

UTEK is known to be seeking to expand its area of coverage. According to the AIC, UTEK officials are interested in meeting with them in Australia to discuss whether the UTEK approach could be adopted there. Expanding the UTEK focus to include New Zealand should be achievable and is certainly worth considering. It is something that could be taken up, perhaps, by Industry New Zealand, perhaps by the Association of Crown Research Institutes. New Zealand government interest in the initiative would be desirable but leadership would not, ie the initiative should stand or fall on its commercial merits.

Finally, there are two further matters worth thinking about that fall somewhat outside the conventional approach to commercialisation. The first is whether the capital markets approach being adopted as part of the national innovation strategy is really in New

Zealand's best interests. As noted in discussing this, there appears to be a very real risk that it will operate in a way that creates a significant risk of losing New Zealand ownership of high performing firms just as they are really starting to succeed.

The second issue is where we place the emphasis in encouraging commercialisation activity. At the moment it is directly on the activity itself. Emerging research suggests that there may be a complementary strategy of investing in improving the quality of the lifestyle environment for the type of people critical to the commercialisation process.

REFERENCES

Athreye, S S (2001) *Agglomeration and Growth: A Study of the Cambridge High Tech Cluster*, Silicon Valley Papers, Stanford University, USA, http://papers.ssrn.com. abstract-220671.

Banda, E, Rubinstein, E and Wigzell, H (2002) *Agents for Change - Bringing Industry and Academia Together to Develop Career Opportunities for Young Researchers,* European Science Foundation, Karolinska Institute, and *Science* magazine, Europe. http://nextwave.sciencemag.org/cgi/content/full/2002/08/26/1?ck=nck

Calvert, J and Patel, P (2002) *University-Industry Research Collaborations in the UK,* Science and Technology Policy Research, University of Sussex, Brighton, UK.

Comptroller and Auditor General (2002) *Delivering the Commercialisation of Public Sector Science,* National Audit Office, London, UK, http://www.nao.gov.uk/ publications/nao_reports/01-02/0102580.pdf.

Davenport, S & Ors (2001) *Leveraging Research and Technology*, paper presented to the R & D Management Conference 2001, Wellington, NZ, 7-9 February.

Department of Innovation, Industry and Regional Development (2002) *Managing and Commercialising Intellectual Property - A Guide for Victorian Universities and Research Institutes* (draft for industry comment), Government of Victoria, Australia, http://www.feast.org/docs/Uni_RI_IP_Framework_final.pdf.

Economic Analysis and Statistics Division of the Directorate for Science, Technology and Industry (2001) *OECD Science, Technology and Industry Scorecard 2001 – Towards a Knowledge-Based Economy,* Section C.5.3 Global Integration of Economic Activities, Cross-Border Ownership of Inventions, OECD, http://www1.oecd.org/publications/e-book/92-2001-04-1-2987/

Executive Office of the President of the United States of America (2003) *Analytical Perspectives, Budget of the United States Government, Fiscal Year 2003,* Washington, USA, http://www.whitehouse.gov/omb/budget/fy2003/pdf/spec.pdf.

Expert Panel on the Commercialization of University Research (1999) *Public Investments in University Research: Reaping the Benefits,* report of the Expert Panel on the Commercialization of University Research, presented to the Prime Minister's Advisory Council on Science and Technology, Canada, http://acst-ccst.gc.ca/comm/rpaper/finalreport4.pdf.

Florida, R (2002a) *The Rise of the Creative Class: and How it is Transforming Work*, Basic Books, New York, USA.

Florida, R (2002b) *The Rise of the Creative Class*, Washington Monthly, May 2002.

Garner, C (2000) *Commercialisation – Part of the Answer?* Research and Enterprise, University of Glasgow, UK, http://www.ragnet.ac.uk/events/reports/00garner/.

House Committee on Science (1998) *Unlocking Our Future: Toward a New National Science Policy,* A Report to Congress, Washington, USA, http://www.house.gov/science/science_policy_report.htm.

Howells, J and McKinlay, C (1999) *Commercialisation of University Research in Europe,* Policy Research in Engineering, Science and Technology, University of Manchester, UK, http://acst-ccst.gc.ca/comm/rpaper/canrp81.pdf.

Jensen, M (2001) *Value Maximisation, Stakeholder Theory, and the Corporate Objective Function*, Negotiation, Organisation and Markets Unit, Harvard Business School Working Paper No. 01-01.

Jonson, P (2002) *Commercialisation Update – November 2002,* Australian Institute for Commercialisation, Melbourne, Australia, http://www.ausicom.com.au/02_latest_news/story_view.asp?rid=122.

Llewellyn-Smith, C H (1997) *What's the Use of Basic Science?,* CERN, Geneva, Switzerland, http://public.web.cern.ch/Public/about/what/basicscience/science.html.

Ministerial Taskforce (2001) *Backing Australia's Ability – An Innovation Action Plan for the Future,* Australia, http://backingaus.innovation.gov.au/docs/statement/backing_Aust_ability.pdf.

Morten, P (2002) *National Benefit and its Application to Publicly Funded Research, Science And Technology Investments,* Foundation for Research, Science and Technology Wellington, NZ, http://www.frst.govt.nz/Publications/papers/NationalBenefit-ItsApplication-Sep02.cfm.

Office of Science and Technology (2000) *Good Practice for Public Sector Research Establishments on Staff Incentives and the Management of Conflicts of Interest,* London, UK, http://www.dti.gov.uk/ost/aboutost/psre.htm.

Performance Based Research Fund Working Group (2002) *Investing in Excellence,* Ministry of Education and Transition Tertiary Education Commission, Wellington, NZ, http://www.tec.govt.nz/Docs/IIE.pdf.

Royal Society of Edinburgh (1996) *Introducing Technology Ventures,* Commercialisation Seminar Reports, December 1996–April 2000, Edinburgh, UK. http://www.ma.hw.ac.uk/RSE/commerc/seminar_reports/commercialisation.pdf.

Science and Innovation Advisory Council (2002) *New Zealanders - Innovators to the World, Turning Great Ideas into Great Ventures: An Innovation Framework for New Zealand,* Ministry of Research, Science and Technology, Wellington, NZ, http://www.siac.govt.nz/innovation/finalreport.pdf.

The Office of the Prime Minister (2001) *Growing an Innovative New Zealand* Wellington, NZ, http://www.beehive.govt.nz/innovate/innovative.pdf.

Valoir, T (2000) *Government Funded Inventions: The Bayh-Dole Act and the Hopkins v CellPro March-In Rights Controversy*, Texas Intellectual Property Law Journal, Vol 8, No. 2. http://www.utexas.edu/law/journals/tiplj/volumes/vol8iss2/valoir.pdf.

Working Party on Technology and Innovation Policy (2002) *Benchmarking Industry Science Relationships,* Committee for Scientific and Research Technology, OECD. http://www1.oecd.org/publications/e-book/9202051e.pdf.

Yencken, J and Gillin, M (revised 2002*)* *Australian University Spin-off Companies: Attitudes, Policies and Companies,* Australian Graduate School of Entrepreneurship at Swinburne, University of Technology Research Paper, Australia, http://www.swin.edu.au/agse/research/AVCC%20Report_Finalg.pdf.

APPENDIX ONE • BARRIERS TO MORE SUCCESSFUL COMMERCIALISATION

An excerpt from an address by Peter Jonson, the Chair of AIC, to the AVCC Deputy and Pro-Vice-Chancellors (Research) Committee (October 2002).

ATTACHMENT A: BARRIERS TO MORE SUCCESSFUL COMMERCIALISATION

The AIC is still a young organisation. In the past 12 months, however, its sponsors have consulted widely about the factors which are blocking better commercialisation of publicly funded R&D in Australia. A summary of these "blocking" issues is set out below - and it is obvious there are major challenges for Australia's research institutions in helping to overcome these "blockers".

1. People and Culture

- Although the situation is improving, there are still significant challenges in matching the ethos and culture of academic researchers with the - timeframes and economic imperatives of the economic and financial communities. We endorse the contribution of I.P. Australia in this area but note that there is much more to be done. (NB: Here and below we interpret the word "academic" to include scientists and technologists working in the major publicly funded research institutes, including CSIRO, ANSTO, DSTO and AIMS.)
- In particular, too often academic researchers seek funds to do research for its own sake rather than to achieve a well defined commercial outcome. Indeed there is still a reasonably widespread ethos that says it is inappropriate to focus too strongly on commercial outcomes, or indeed to "get rich" from commercialising science and technology.
- Historically Australia has a low tolerance for failure and therefore an inappropriately high aversion to risk, particularly in publicly funded research organisations. We need to encourage wider appreciation of the basic fact that seeking high returns requires risks to be taken and that the failure of some high risk ventures is inevitable.
- Entrepreneurship is in part a learnt or acquired skill - education systems, particularly at tertiary levels, need to foster in students an appetite for establishing and growing businesses.
- In many research institutions incentives for researchers to participate equitably in commercialisation are too low - the appropriate "division of the spoils" needs to be addressed and resolved in such institutions, and there may be more than one effective system.
- Incentives for researchers generally, including aspects of Australia's tax system, need attention.

2. Knowledge and Awareness

- There is clear evidence of a simple lack of knowledge and awareness of the potential benefits of commercialisation among many researchers in Australia. Australia generally needs to learn from the commercialisation activities occurring in the most successful overseas research institutions, as well as our own success stories.
- Financiers say there is no shortage of funds for good projects whilst many scientists complain of lack of funds or about the terms on which funds are available. This "commercialisation chasm" needs to be bridged, and there is a clear facilitation role to be played by governments and organisations such as the AIC.
- There is a major shortage of people with the skills to manage and/or act as directors for research based start-up companies in Australia, and there is a real need to identify/foster/develop/pass on commercialisation skills via apprenticeship and mentoring. (The AIC is working with the Institute of Company Directors (AICD) and other organisations such as the Association of Venture Capitalists (A VCAL) on this matter, but assistance from government may be required.)

3. Intellectual Property Matters

- There is widely held belief that much IP is lost through delay/poor legal advice and practices and simply by lack of knowledge; some researchers simply do not follow the sensible rules laid down by their employers.
- There is a variety of practices both to protect intellectual property and to reward inventors in the Australian research sector – a strong effort needs to be made to seek out best practice and apply it widely, noting that there may not be a single "best" model but possibly several competing models.
- Where models are different - and compare the approach to IP "ownership" in CSIRO with Melbourne University for example - devising more effective ways to collaborate is a serious challenge.

3. Best Unbiased Advice, Benchmarks

- It is very difficult for many researchers to obtain " hard-nosed, accurate, confidential, unbiased advice and subsequent support". Organisations such as the AIC are needed to provide this-
- The research community needs education on what widely accepted market standards are in the commercialisation process, including the costs of advisors and the share required by venture capitalists and other financiers.
- There is little solid measurement of Australia's commercialisation efforts in relation to world's best practice although what evidence there is suggests there is a lot of room for improvement - a serious effort to obtain relevant benchmarks for number and value of patents, licences and spin-out companies will help to establish a far more solid framework for expectations and performance.
- Just as the higher education and research system in general is fragmented, so too are the related commercialisation efforts. Creating a far smaller number of far more

effective university commercialisation units (with each unit serving several universities) would appear to make a great deal of sense - Uniseed is the best example of this known to us, but others need to be fostered.

Source: AIC Submission to Higher Education Review, Number 349, July 31, 2002.

APPENDIX TWO • BAYH-DOLE ACT

THE BAYH-DOLE ACT
A GUIDE TO THE LAW AND IMPLEMENTING REGULATIONS

COUNCIL ON GOVERNMENTAL RELATIONS

September 1999

Introduction

The transfer of new technology from university laboratories to the private sector has a long history and has taken many different forms. The current national emphasis on this activity, however, can be dated to the 1980 enactment of P.L. 96-517, The Patent and Trademark Law Amendments Act, more commonly known as the Bayh-Dole Act, and amendments included in P.L. 98-620, enacted into law in 1984.

This brochure reviews the Bayh-Dole legislation, the implementing regulations that have evolved, and the major issues associated with complying with the law and related regulations. It also highlights the significant benefits of the Bayh-Dole Act that impacts have occurred to date.

Background

Technology transfer--the transfer of research results from universities to the commercial marketplace for the public benefit--is closely linked to fundamental research activities in universities. Although a handful of U.S. universities were moving science from the laboratory to industrial commercialization as early as the 1920s, academic technology transfer as a formal concept, is said to have originated in a report entitled "Science - The Endless Frontier" that Vannevar Bush wrote for the President in 1945. At that time, the success of the Manhattan Project had demonstrated the importance of university research to the national defense. Vannevar Bush, however, also recognized the value of university research as a vehicle for enhancing the economy by increasing the flow of knowledge to industry through support of basic science. His report became instrumental in providing a substantial and continuing increase in funding of research by the federal government. It stimulated the formation of the National Institutes of Health (NIH), the National Science Foundation (NSF), and the Office of Naval Research (ONR). Due to the success of these and other agencies, the funding of basic research by the federal government is now considered to vital to the national interest.

In the 1960s and 1970s, there was much study and debate surrounding federal patent policies. A major concern was the lack of success by the federal government in promoting the adoption of new technologies by industry. There was no government-wide policy regarding ownership of inventions made by government contractors and grantees under federal funding. Inconsistencies in policies and practices among the various funding agencies resulted in a very limited flow of government-funded inventions to the private sector. In 1980, the federal government held title to approximately 28,000 patents.

Fewer than 5% of these were licensed to industry for development of commercial products.[1]

This problem was due, in part, to restrictions imposed on the licensing of new technologies and reluctance on the part of the agencies to permit ownership of inventions to vest in universities and other grantees.[2] The government would not relinquish ownership of federally funded inventions to the inventing organization except in rare cases after petitions had moved through a lengthy and difficult waiver process. Instead, the government retained title and made these inventions available through non-exclusive licenses to anyone who wanted to practice them.

As a result, companies did not have exclusive rights under government patents to manufacture and sell resulting products. Understandably, companies were reluctant to invest in and develop new products if competitors could also acquire licenses and then manufacture and sell the same products. Accordingly, the Government remained unsuccessful in attracting private industry to license government-owned patents. Although taxpayers were supporting the federal research enterprise, they were not benefiting from useful products or the economic development that would have occurred with the manufacture and sale of those products.

In 1980, however, legislators and the administration concluded that the public would benefit from a policy that permitted universities and small businesses to elect ownership of inventions made under federal funding and to become directly involved in the commercialization process. This new policy would also permit exclusive licensing when combined with diligent development and transfer of an invention to the marketplace for the public good. It was understood that stimulation of the U.S. economy would occur through the licensing of new inventions from universities to businesses that would, in turn, manufacture the resulting products in the U.S.

Evolution

With the passage of the Bayh-Dole Act, colleges and universities immediately began to develop and strengthen the internal expertise needed to effectively engage in the patenting and licensing of inventions. In many cases, institutions that had not been active in this area began to establish entirely new technology transfer offices, building teams with legal, business, and scientific backgrounds. These activities continue to accelerate nationally as the importance of the Bayh-Dole Act becomes fully appreciated. Evidence of this is reflected in the fact that the membership of the Association of University Technology Managers (AUTM) increased from 200 in 1990 to 800 in 1999. 691 in 1989 to 2,178 in 1999. In 1979, the year before passage of the Bayh-Dole Act, the Association counted only 113 members. [3]

University technology transfer offices perform a wide variety of highly specialized functions related to the patenting and licensing of inventions. In addition, these offices also perform a vital function at their institutions related to the formation of research partnerships with industry, and in negotiating the exchange of research materials and research tools.

In recent years, the wisdom of the new federal policy has become increasingly apparent. Growing numbers of universities have demonstrated that their newly formed technology transfer programs are effective in licensing inventions made with federal support to commercial partners. As a result, many new technologies have been diligently and successfully introduced into public use.

Another significant result of the Bayh-Dole Act is that it provides a strong incentive for university-industry research collaborations. At the national level, industry support for research and development at universities represents less than 7% of the total funding of university-based research. While small compared to the 60% provided by federal agencies, this private investment in the creativity of universities, including professors, students and staff, drives a form of technology transfer that is increasingly important to industry. The investment by industry rests on a secure footing because is it is based on the principles and provisions of the Bayh-Dole Act.[4]

Some Perspective

The principles of the Bayh-Dole Act were the result of years of intense and emotional debate, dealing with fundamental concerns. The record shows that the debate included such issues as whether exclusive licenses would lead to monopolies and higher prices; whether taxpayers would get their fair share; whether foreign industry would benefit unduly; and whether ownership of inventions by a contractor is anti-competitive. Safeguards were hammered out in numerous legislative drafts. It is certain that the Act became much stronger because of the thorough debate that took place prior to its passage.

From the beginning, it was obvious that economic interests rather than academic science interests were the driving forces for the change in government policy. As early as October l963, President Kennedy had issued a Presidential Memorandum and Statement of Government Policy. This memorandum marked the beginning of an intense discussion about the effect that government patent policy had on commercial utilization of federally sponsored inventions, on industry participation in federally sponsored R & D programs, and on business competition in the marketplace.[5] It was not until industry, academe and the government recognized that their individual interests could be reconciled in the pursuit of commercialization that passage of the Bayh-Dole Act became possible and ended years of debate.

Until the Bayh-Dole Act became effective on July 1, 1981, the federal agencies kept tight control over intellectual property rights resulting from funded research, premised largely on traditional expectations rooted in the procurement process. After the passage of the Bayh-Dole Act, codifying and implementing it at the agency level was not an easy process. As the success of the Act became quickly apparent, subsequent legislative initiatives broadened its reach even further. These initiatives and the technical amendments involved are described in the Appendix.

Current Regulations

Regulations implementing federal patent and licensing policy regarding "Rights to Inventions Made by Non-profit Organizations and Small Business Firms" are codified at 37 CFR Part 401. The Department of Commerce is designated as the federal agency to promote commercialization and to assume responsibility for maintaining these rules.[6] The following summarizes the significant aspects of these regulations:

- The provisions apply to all inventions conceived or first actually reduced to practice in the performance of a federal grant, contract, or cooperative agreement. This is true even if the Federal government is not the sole source of funding for either the conception or the reduction to practice. The provisions do not, however, apply to federal grants that are primarily for the training of students and postdoctoral scientists.

- The university is obligated to have written agreements with its faculty and technical staff requiring disclosure and assignment of inventions.
- The university has an obligation to disclose each new invention to the federal funding agency within two months after the inventor discloses it in writing to the university.
- The decision whether or not to retain title to the invention must be made within two years after disclosing the invention to the agency. This time may be shortened, if, due to publication of research results or public use, the one-year U.S. statutory patent bar has been set in motion. Under such circumstances, the university must make an election at least sixty days before the end of the statutory period. If the university does not elect to retain title, the agency may take title to the invention.
- Upon election of title, the university must file a patent application within one year, or prior to the end of any statutory period in which valid patent protection can be obtained in the United States. The university must, within ten months of the U.S. filing, notify the agency whether it will file foreign patent applications. If the university does not intend to file foreign applications, the agency may then file on its own behalf in the name of the United States.
- Universities must include within the specification of the patent a notification of government support of the invention and government rights in the invention.
- If the university elects to retain title, the university must provide the government, through a confirmatory license, a non-exclusive, non-transferable, irrevocable, paid-up right to practice or have practised the invention on behalf of the U.S. throughout the world.
- The university must submit periodic reports regarding the utilization of the invention as requested by the funding agency, but no more often than annually.
- Any company holding an exclusive license to a patent that involves sales of a product in the United States must substantially manufacture the product in the U.S. Waivers of this rule may be granted by the Federal agency upon a showing that reasonable but unsuccessful efforts had been made to find a company that would manufacture the product in the US, or that manufacture in the US would not be economically feasible.
- In their marketing of an invention, universities must give preference to small business firms (fewer than 500 employees), provided such firms have the resources and capability for bringing the invention to practical application. However, if a large company has also provided research support that led to the invention, that company may be awarded the license.
- Universities may not assign their ownership of inventions to third parties, except to patent management organizations.
- Universities must share with the inventor(s) a portion of any revenue received from licensing the invention. Any remaining revenue, after expenses, must be used to support scientific research or education.
- Agencies may decide, for compelling reasons, that title should be vested in the federal government. Such decisions must be consistent with provisions within the Bayh-Dole Act and made in writing before entering into a funding agreement with a university. The agency must also file a Determination of Exceptional Circumstances (DEC) with the Department of Commerce. The NIH, for instance, has issued several

DECs for programs where NIH determined it was necessary to protect rights in intellectual property obtained from third parties.[7]

- Under certain circumstances, the government can require the university to grant a license to a third party, or the government may take title and grant licenses itself (these are called "march-in rights"). This might occur if the invention was not brought to practical use within a reasonable time, if health or safety issues arise, if public use of the invention was in jeopardy, or if other legal requirements were not satisfied.[8]

Procedural details, other rights and obligations not cited above, and further information regarding these matters, can be found in 37 CFR Part 401 and 35 USC 200-212.

Related NIH Policies

On November 8, 1994 the NIH published a notice in the Federal Register (59 FR 55673) entitled: "Developing Sponsored Research Agreements: Considerations for Recipients of NIH Research Grants and Contracts." This document is intended to ensure compliance with the requirements of the Bayh-Dole Act by providing NIH awardees with guidance in developing sponsored research agreements with commercial entities when that research may be partially funded by NIH or other federal agencies.

The NIH also issued two policy statements in the NIH Guide (Volume 25, Number 16, May 17, 1996; and Volume 25, Number 29, August 30, 1996) that establish procedures for managing certain patentable inventions. These rules apply to situations in which a university wishes to elect title to biological materials, which may be patentable, but does not want to file a patent application because the cost is not justified or because the patentability of the materials appears to be weak.

In May l999, the NIH published a proposed set of guidelines for grantees on the subject of obtaining and disseminating biomedical research resources.[9] This guidance is intended to help avoid or minimize problems that sometimes result from the dissemination and use of proprietary research tools that involve the competing interests of intellectual property owners and research users. NIH issued this guidance because, as a public sponsor of biomedical research, it has a dual interest in accelerating scientific discovery through the use of research tools and facilitating product development.

Compliance with Bayh-Dole Act Regulations

When a university elects title to an invention, it assumes responsibility for taking certain actions to properly manage the invention and provide certain reports to the government regarding the invention as outlined in the section on Current Regulations above. Compliance with these obligations is critical to the success of, and ongoing federal support for, the Bayh-Dole Act. As public and Congressional interest in technology transfer increases, and as the volume of activity continues to grow, government reviews of the practices of institutions involved in the process of commercialization of inventions will be conducted more frequently. Accordingly, there will be an increasingly greater need for attention to the details involved in meeting Federal reporting obligations and other requirements imposed by 37 CFR Part 401.

Each Federal agency is responsible for maintaining and monitoring its own repository of information on inventions developed under its funding. In October 1995, the NIH established the "Interagency Edison" system, an electronic reporting system whereby

universities can enter data directly into a national database to satisfy their reporting obligations to those Federal agencies participating in the system.

Federal agencies have the authority to periodically audit grantees and contractors for compliance with the Bayh-Dole Act. The General Accounting Office (GAO) in turn may also conduct studies to assess how effectively Federal agencies are overseeing their grantees and contractors in the management of government-funded inventions. 35 U.S.C. Section 202(b)(3) requires the Comptroller General to review the implementation of the Bayh-Dole Act at least once every five years and report its findings to the Judiciary Committees of the House and Senate. In 1991, the GAO focused its review on the licensing of Federal-federally owned inventions (GAO/RCED-91-80 issued April 3, 1991). In 1992, the GAO reviewed federal agency mechanisms for controlling inappropriate access to federally funded research results (GAO/RCED-92-104 issued May, 1992). More recently, the GAO reviewed the implementation of the Bayh-Dole Act by research universities (GAO/RCED-98-126 issued May 7, 1998). In 1999, GAO issued a report on the number and characteristics of inventions licensed by six federal agencies (GAO/RCED-99-173, issued June 1999) and a report on compliance with reporting requirements for federally sponsored inventions (GAO/RCED-99-242, issued August 12, 1999). The GAO reports can be obtained from the Government Printing Office. See Web Resources below.

In order to assist grantees in their efforts to maintain compliance with regulatory compliance of the Act, some federal agencies have periodically issued guidance to the grantee community. An example is a question and answer document regarding invention reporting, printed in the NIH Guide to Grants and Contracts in l995. (NIH Guide, Vol.24, No.33, September 22, l995).

Results of the Bayh-Dole Act

University patenting and licensing efforts under the Bayh-Dole Act have fostered the commercialization of many new technological advances that impact the lives of millions of people across the nation. A recent national survey17 conducted by AUTM[10] reports that 70% of the active licenses of responding institutions are in the life sciences--yielding products and processes that diagnose disease, reduce pain and suffering, and save lives. Most of the inventions involved were the result of Federal funding. While it would be impossible to list all such inventions, a few examples of technologies and products originating from federally funded university discoveries include:

- Artificial lung surfactant for use with newborn infants, University of California
- Cisplatin and carboplatin cancer therapeutics, Michigan State University
- Citracal® calcium supplement, University of Texas Southwestern Medical Center
- Haemophilus B conjugate vaccine, University of Rochester
- Metal Alkoxide Process for taxol production, Florida State University
- Neupogen® used in conjunction with chemotherapy, Memorial Sloan Kettering Cancer Institute
- Process for inserting DNA into eucaryotic cells and for producing proteinaceous materials, Columbia University
- Recombinant DNA technology, central to the biotechnology industry, Stanford University and University of California

- TRUSOPT® (dorzolamide) ophthalmic drop used for glaucoma, University of Florida

These examples of successful new technologies demonstrate that a strong national infrastructure to support technology transfer has been established at academic institutions across the nation since passage of the Bayh-Dole Act. In 1980 there were approximately 25-30 universities actively engaged in the patenting and licensing of inventions. It is estimated that there has been close to a ten-fold increase in institutional involvement since then. National survey findings[18] reflect. The AUTM survey reflects the impact of this growth in activity:

- Academic institutions were granted more than 8,000 U.S. patents between 1993 and 1997 for technologies discovered by their researchers.
- Over 2,200 new companies have been formed since 1980 that were based on the licensing of an invention from an academic institution, including over 330 companies formed in FY 1997 alone.
- Approximately $30 billion of economic activity each year, supporting 250,000 jobs can be attributed to the commercialization of new technologies from academic institutions.
- There are more than 1000 products currently on the market that are based on university licensed discoveries.
- Technologies licensed from academia have been instrumental in spawning entirely new industries, improving the productivity and competitiveness of companies, and creating new companies and jobs. [11]

In summary, the Bayh-Dole Act and its subsequent amendments created incentives for the government, universities, and industry to work together in the commercialization of new technologies for the public benefit. The success of this three-way partnership cannot be understated.

Conclusions

On a nation-wide basis, the results support the conclusion that the Bayh-Dole Act has promoted a substantial increase in technology transfer from universities to industry, and ultimately to the public. Certainty of title to inventions made under federal funding is perhaps the most important incentive for commercialization. Implementation of uniform patenting and licensing procedures, however, combined with the ability of universities to grant exclusive licenses, are also significant ingredients for success. This combination of factors led to a tremendous acceleration in the introduction of new products through university technology transfer activities.

Certainty of title to inventions made under Federal funding has one other significant benefit—it protects the right of scientists to continue to use and to build on a specific line of inquiry. This is fundamentally important to research-intensive institutions because of the complex way in which research is typically funded, with multiple funding sources. The retention of title to inventions by the institution is the only way of ensuring that the institution will be able to accept funding from interested research partners in the future. This is a critically important benefit of the Bayh-Dole Act that is not widely understood.

As Vannevar Bush foresaw, enormous benefits to the U.S. economy have occurred because of Federal funding of research. These benefits have been significantly enhanced by the adoption of federal policies encouraging technology transfer. Such policies have led to breathtaking advances in the medical, engineering, chemical, computing and

software industries, among others. The licensing of new technologies has led to the creation of new companies, thousands of jobs, cutting-edge educational opportunities and the development of entirely new industries. Thus, accordingly, the Bayh-Dole Act continues to be a national success story, representing the foundation of a successful union among government, universities, and industry.

Web Resources

· http://www.nih.gov/grants/policy (search for NIH Bayh-Dole-related policies)

· http://www.access.gpo.gov/ (GAO and other federal reports)

· http://137.187.120.232/ (Interagency Edison project)

· http://www.autm.net (AUTM home page)

· http://www.cogr.edu/ (COGR home page)

Appendix ● Bayh-Dole Act and Related Legislation

The Bayh-Dole Act and subsequent amendments provide the basis for current university technology transfer practices. The federal patent and licensing policy was shaped by four events that occurred between 1980 and 1985.

1. On December 12, 1980, P.L. 96-517, the Bayh-Dole Act was enacted into law. After lengthy and contentious congressional debate, legislation was crafted that created a balance between incentives and controls. Universities applauded the legislation because a uniform federal patent policy was established that clearly stated that universities may elect to retain title to inventions developed under government funding. Industry, particularly the small business community, appreciated an ownership policy that was applied uniformly on a government-wide basis. In addition, industry expected to benefit from the message that universities were encouraged to collaborate with companies to promote the utilization of inventions arising from federal funding, that preference in licensing be given to small business, and that, to the extent possible, licensed products were to be manufactured in the U.S. The federal government, in turn, was assured that universities would file, at university expense, patent applications on inventions they elected to own. In addition, the government retains rights to enforce diligent commercial development of inventions. It also enjoys royalty-free, non-exclusive licenses to practice federally funded inventions throughout the world for government purposes.

2. On February 10, 1982, the Office of Management and Budget issued OMB Circular A-124 to provide guidance to federal agencies regarding implementation of the Bayh-Dole Act. This Circular established standard patent rights clauses for use in federal funding agreements. It also set up standard reporting requirements for universities electing title to inventions.

3. On February 18, 1983, a Presidential Memorandum on "Government Patent Policy" was issued. This Memorandum was issued to satisfy those that recognized the benefits of the legislation and wanted broader coverage. The Presidential Memorandum directed federal agencies to extend the terms and provisions of the Bayh-Dole Act to all government contractors, with a follow-on amendment to the Federal Acquisition Regulations to assure that all federal R&D agencies would implement the Act and the Memorandum.

4. On November 8, 1984, the original Bayh-Dole statute was amended by P.L. 98-620. New language was added to remove term limitations placed on exclusive licenses under

the original Act. In addition, the Department of Commerce was designated as the federal agency responsible for overseeing the implementation of the Bayh-Dole Act and for monitoring the granting of exceptions to the rules.

On March 18, 1987 (52 FR 8552), all of the relevant provisions--the Bayh-Dole Act, the amendment, OMB Circular A-124, and the Presidential Memorandum--were finalized and consolidated in a rulemaking published by the Department of Commerce—appearing at 37 CRF Part 401. These regulations, augmented by the NIH guidelines discussed in this brochure, specify the rights and obligations of all parties involved and constitute the operating manual for technology transfer on a national basis.

Footnotes

---

[1] U.S. Government Accounting Office (GAO) Report to Congressional Committees entitled "Technology Transfer, Administration of the Bayh-Dole Act by Research Universities" dated May 7, 1998.

[2] The term "university" or "universities" as used in the text applies to all non-profit grantees /contractors.

[3] We gratefully acknowledge the courtesy and cooperation of AUTM in providing these statistics. See also AUTM Licensing Survey FY1991-1995 and subsequent years.

[4] In 1997, federal agencies provided an estimated $14.3 billion or about 60% of total support for research performed at universities. Academic institutions provided $4.5 billion of their own funds. State and local governments and non-profit organizations each contributed $18.1 billion and industry $1.7 billion. Although the proportion of academic R&D expenditures supplied by industry has been rising fairly steadily, it still only represents a fraction (7%) of total academic R&D support. Science and Engineering Indicators 1998. National Science Board: 4-8 and 4-9.

[5] Presidential Memorandum and Statement of Government Patent Policy, issued October 10, 1963. Published in the Federal Register, Vol. 28, No. 200.

[6] The Secretary of Commerce delegated this authority under 35 USC 206 to the Assistant Secretary for Productivity, Technology and Innovation.

[7] Other circumstances, not clearly elucidated in the regulations, may be invoked by the government. Further detail can be found in 37 CFR Part 401.3; general appeal mechanisms are found in Part 401.4.

[8] March-in rights, including appropriate procedures, are described at 37 CFR Part 401.6.

[9]. Notice for Public Comment, 64 FR 100, 28205-28209.

http://www.cogr.edu/bayh-dole.htm - ednref10

[10] AUTM Licensing Survey, Fiscal Year 1997.

[11] AUTM press release December 17, 1998.