FEDERATION OF AUSTRALIAN SCIENTIFIC AND TECHNOLOGICAL SOCIETIES

Science and Technology for the Social, Environmental and Economic Benefit of Australia

FASTS Occasional Paper Series

Number 2 April 1999

Scientists commercialising their research

$20

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This study was carried out with the assistance of a grant from the Commonwealth Department of Industry, Science and Resources.

We acknowledge and thank the scientists and technologists who took part in the focus group studies for their generous and enthusiastic contribution.

Note: The paper summarises the comments of the focus group participants, and does not necessarily reflect the opinion of FASTS or the authors of this report.

Executive summary

Scientists and technologists are under increasing pressure from their organisations to commercialise their work. Some have encountered obstacles in this process. This study identifies these obstacles and the recommendations of scientists to overcome them, through focus group discussions with 126 scientists across Australia.

The obstacles the participants identified are:
1. attitudes and understanding by scientists
2. lack of commercial advice for scientists
3. lack of time and flexibility in research
4. lack of rewards for scientists involved in commercial work
5. valuing intellectual property (IP)
6. Australia's Taxation system
7. the funding gap and Government support schemes
8. cultural obstacles within research organisations
9. cultural gaps with industry
10. cultural gaps with Government
11. cultural obstacles within the Australian community

Participants were able to nominate an imposing list of challenges posed by commercialisation, and to identify potential or actual solutions. Those who had experienced the commercial process a number of times find the greatest impediments were issues such as discrepancies between the way capital gains tax (CGT) applies in Australia and the US. They recommend that CGT be applied as it is in the US.

Those coming to commercialisation for the first time find impediments at a different level. They find it hard to put a value on their work or even to recognise when something is of commercial value. They need (among other things) assistance with writing business plans, applying for START Scheme grants and handling intellectual property (IP) issues. This group recommend a stronger system of providing advice, through mentoring groups or strengthening the technology transfer skills of research organisations.

All participants had met hurdles which required persistence and time to overcome, and some said that the effort involved was not worth the potential rewards. Among the hurdles were a risk-averse industry sector, government support schemes which seemed bureaucratic and short-sighted, or research organisations which lacked the skills to support entrepreneurial-minded staff.

Many participants recognise that they lack the skills to handle the commercialisation process, being unused to the ways of industry and of the steps needed to gain private sector support for their work.

Some participants described a cultural attitude among their colleagues of looking down on commercial science as 'second-rate work', an attitude they feel can also be applied to the research organisations which employ them. These organisations are criticised for making promotions and appointments on the basis of the number of academic papers an applicant had published rather than commercial activities, notwithstanding formal policies to the contrary.

A common thread among the more experienced participants is their critical view of the risk-averse nature of Australia institutions. Commercial failure in Australia is assumed to be evidence of incompetence or second-rate science, but in the USA it is regarded as an essential part of the learning curve. As one participant said: "My life is insured for $US 12 million, and I am regarded as hot property in the US because I've been to the market once and failed. That experience is invaluable."

The groups identify positive signs as well. Cooperative Research Centres are seen as sources of encouragement and expertise in helping scientists and technologists commercialise their work. There are some positive reports of SPIRT and START grants, and the dealings scientists had in negotiating applications for these grants with officers of Government departments. Some universities and their technology transfer arms are recognised as being knowledgable and far-sighted.

The recommendations from the focus groups fall into eight broad areas:

1. develop a long term strategy to change cultural attitudes in Australia, to foster acceptance and support for research-driven, high technology industries as creators of wealth and jobs

2. make Australia a more attractive place for industry and capital to invest in high-tech enterprises, by refining Government support programs and reviewing taxation settings

3. develop formal and informal programs to build the skills of scientists and research managers in the commercialisation process, and create mentoring and incubator systems to help commercially-minded scientists

4. build public awareness of the power of science to generate wealth and create high-quality jobs, by using role models and case studies of successful industries and entrepreneurial scientists

5. review the incentive systems in universities and research organisations, so that commercial activities are properly rewarded

6. develop a more realistic approach to IP in universities and research organisations, to recognise and protect IP and ensure it is handled to maximise appropriate commercial activity

7. encourage people from research and industry to interact more freely, through industry sabbaticals, informal networks and flexible structures which encourage free movement between the two sides

8. increase Government investment in research in line with recent moves in the US, the UK, Japan and Germany

Introduction

Scientists and technologists are under increasing pressure to commercialise the results of their work. Governments, funding agencies, universities and research organisations are all seeking greater returns on their investment in research, and are increasing pressure on researchers to generate income through royalty streams, licensing fees or taxation revenue generated by new industrial enterprises. Some scientists have succeeded in responding to this new expectation, but others have met with obstacles.

This study set out to establish the nature of these obstacles by talking to the people most intimately involved, the scientists and technologists conducting the research. As well as asking scientists to identify the obstacles, it also asked them to suggest changes to help surmount these obstacles.

One hundred and twenty six scientists and technologists took part in 14 focus group discussions across Australia (See Appendix 2 for list of participants). They discussed the impediments which hinder them from commercialising the results of their research, and identified policy and organisational changes which would promote commercialisation.

Participants ranged in seniority from deputy vice-chancellors, Cooperative Research Centre (CRC) directors and professors, to junior research scientists. Their experience with commercialisation ranged from extensive to minimal. Some participants led research teams which had commercialised work: others had specific duties which included commercialisation. A third group had been closely involved in the commercialisation of work without having those specific duties.

Method

Focus groups were held in Brisbane, Townsville, Sydney, Melbourne, Canberra, Adelaide and Perth, with 126 volunteer participants. At each discussion, participants were invited to address general questions in a free-ranging and largely undirected discussion. The groups were occasionally prompted or steered on to a new topic by a question from the chair ("What sort of experiences have people had with Government-support schemes?"). See Appendix One for moderator's guide.

In the final 15 minutes of each discussion, the group were invited to identify (individually) what they saw as the major problems to be overcome; and these comments were written on a whiteboard.

Discussions were scheduled to last for 75 minutes but rarely lasted for less than 90 minutes because participants were keen to tell of their own experiences and learn from the experiences of others in the group. Even at the end of the formal session participants exchanged cards and wanted to carry the discussions further. This emphasises one key finding: that the participants were hungry for information and often referred to the need for a "mentoring group".

Extensive notes were taken of each group discussion, and these were circulated in draft form to participants for comment and correction. The corrected notes were subjected to content analysis, a process which elicited the main issues discussed in this paper.

The participants

Participants were self-nominating. They responded to an invitation to join the focus groups after the study was advertised by email through the Member Societies of FASTS, R&D organisations and other networks. The response to a few email messages calling for participants was overwhelming, and a scheduled five focus groups had to be expanded to fourteen to cater for the demand. The FASTS' networks proved effective in spreading messages quickly through the scientific community.

Participants identified themselves as belonging to organisations as follows:

Universities	58
CRCs	23
CSIRO	17
Government departments	8
Industry	7
Organisations, councils	7
Government-funded R&D	6
TOTAL PARTICIPANTS	126

Many had significant experience with commercialisation of R&D, with some having specific responsibilities for this area in their organisation. The remainder had some interest in commercialisation, usually because their work had commercial possibilities which they were beginning to explore.

(A full list of participants in contained in Appendix 1)

Detailed findings

This section outlines each of the eleven obstacles to the commercialisation of research results, as described by the scientists and technologists participating in the focus groups. For each barrier outlined, there were a number of recommendations made by focus group participants on how to improve the situation.

Please note:
a. these summaries are weighted to reflect the frequency of particular comments
b. the recommendations which follow each section are listed in an order which approximately reflects the number of times they came up in the focus group discussions
c. each section summarises the comments of the focus group participants, and does not necessarily reflect the opinion of FASTS or the authors of this report.

Barrier 1 Attitudes and understanding by scientists

Thinking commercial does not come naturally to scientists. They do not see careers in the commercial world or recognise the problems that industry is trying to solve. The less experienced focus group participants reported a poor knowledge of the processes of commercialisation, and as one said: "We don't know what we don't know." Some find it difficult to recognise when their work is potentially valuable to commercial interests, or to put a value on themselves. These participants do not understand the processes of industry or appreciate the pressures from shareholders on individual companies to perform, or appreciate the real costs of experimental work.

There is a lack of "translators" who can speak both the language of industry and the language of research. The gap between research and industry is accentuated by the attitude of some of their colleagues, who look down on commercial work as being "dirty science" which can lead to conflicts of interest. For this group, the thrill is in the discovery, the rewards are in publishing papers, and they do not care about the commercial implications of their work. Scientists are trained to produce scientific 'truths', and the outcomes of their work are left at the scientific level and are not translated.

Recommendations from the group

- Change graduate and post-graduate science curriculums to educate students in commercialisation and business skills
- Encourage post-graduate students to undertake doctorates in technology rather than PhDs, with an emphasis on the multi-disciplinary skills as opposed to the narrow single-disciplinary focus
- Encourage scientists to develop business skills through enterprise workshops and courses
- Provide role models of success stories ("more Ferraris in the carpark"), and generate positive messages about the entrepreneurial culture
- Stimulate the interaction between industry and research through sabbaticals in industry for researchers, and by bringing industry people to universities as guest lecturers
- Build awareness of what is needed to translate a science outcome into the market place, and provide incentives to market
- Put in place appropriate industry-focussed boards for R&D groups

Barrier 2 Lack of commercial advice for scientists

Scientists who were not experienced in commercialisation feel an acute need for good advice on all aspects of commercialising their work. "I see myself as a babe in the woods." This advice has to be accessible from the very first stages when scientists are uncertain whether it is appropriate to commercialise their work; and should cover issues like patenting where the complexity of the issues can be such that the research is finished before the patent agreement is secured.

There is a shortage of people who can help with matters like developing a business plan and steering basic research through the commercialisation process. Some participants suggest a team approach,

where skills in marketing and finance are combined with an understanding of the technology. Quality is an issue, and participants report on the highly variable experience and outlook of people or organisations in this area. A positive environment needs to be created for those scientists with entrepreneurial flair, the "cowboys" of the research world. The international nature of some specialised markets is an additional challenge.

Scientists find it challenging to build their commercial skills and still maintain a research program. They find industry surprisingly reticent at coming to them, and express surprise at how few industry people come to research bodies in search of commercialisable ideas. It is a challenge for them to break through the "business club mentality", or to find an industry person keen to understand the science and champion the research

Recommendations from the group

- Increase the number of entrepreneurial people who can link between the science and business worlds, the "rare birds" who can comfortably straddle both worlds
- Encourage the formation of teams of advisers who can work with scientists on commercialisation, at both a formal and informal level
- Encourage "head hunters" who can scour the research organisations for ideas and sell them on to industry
- Improve the quantity of assistance with patenting and contracts, perhaps by consolidating the existing university technology transfer groups into five major national groups
- Provide incentives to people in technology transfer groups through offering a "slice of the action"
- Extend government funding schemes to cover the cost of patenting, writing a business plan and marketing

Barrier 3. Lack of time and flexibility in research

Successful commercialisation often requires a product champion, and this is a time-intensive process ("Ten years of hard slog"). It needs a person of particular confidence and persistence to succeed, and scientists are often the best people to 'sell' work because they understand and believe in it. By contrast, it is a rare business person who is keen to understand the science and champion the research. Being a product champion can remove scientists from their normal tasks for years - research, teaching, making grant applications, writing papers. Often it takes scientists a long way from where they want to be, although some would like to have a foot in both camps.

Research organisations and scientists underestimate the time, effort and money it takes to drive the commercialisation process. Scientists say they find it impossible to be all things to all people, and it is particularly hard for a lone entrepreneurial academic to survive.

Recommendations from the group

- Create flexible career paths to allow scientists to move from research to start spin-off companies (and back again)
- Create technology incubators and provide facilities to allow scientists to develop their ideas to an investment-ready stage
- Devise ways for research organisations to give scientists relief from normal duties to champion their products
- Pay university researchers for nine months work, and let them earn money from industry for the other three months (as in US)
- Create "chaotic groups" by throwing together innovative scientists from different disciplines, in an atmosphere where they are encouraged to think laterally in commercial terms
- Build better links between former employees in start-up companies and research organisations by allowing access to facilities like libraries, and encouraging student training and continuing research

Barrier 4. Lack of rewards for scientists involved in commercial work

Participants feel that the techniques research organisation use to measure talent are not fair. Scientists are rewarded on the basis of the publication rate and gaining Australian Research Council (ARC) grants rather than any commercial activities, despite publicly-stated policies to the contrary. Participants report missing normal promotion stages because commercialisation activities remove them from 'mainstream' activities. Scientists find themselves being confronted with an unpalatable choice between choosing academia or championing the product. Commercialisation is not easy - scientists have to be hungry to succeed and research organisations are seen as not having the administrative flexibility to offer options to scientists pursuing commercial lines.

Those rewards systems in place for commercial activities are regarded as remote, slow, obscure and largely ineffectual. Reward systems need to be sufficiently flexible to recognise team efforts and special efforts. Although patents and commercial work can take a lot longer and incur higher costs than a paper ("one patent is worth 15-20 papers"), the effort is not generally recognised in promotions and appointments. This is despite a far more rigorous checking process on patent applications than on screening papers for publication. This attitude is hindering the growth of spin-off companies.

In some cases scientists are simply expected to hand the technology over to research administrators. Research units can lose ground by having one of their team involved in commercialisation, which causes resentment among the rest of the team. Units experiencing commercial success are sometimes 'rewarded' by the research organisation increasing the target revenue to be generated, or having other funding reduced. "Why would you want to go through the arduous commercialisation process?"

There is some feeling that the picture is beginning to change, that ability to attract commercial funds and commercialise work is beginning to be rewarded by some research organisations.

Recommendations from the group

- Change promotion and appointment criteria in universities and research organisations, to give greater weight to commercial activities
- Develop more flexible and more sophisticated reward systems
- Give scientists equity (rather than royalties) in any commercial development of their ideas
- Change conditions of employment to allow for a base salary retainer, with additional salary as proportion of funds gained by commercial activities

Barrier 5. Valuing intellectual property

Scientists find it difficult to put a value on their IP, or even to recognise when they have discovered something of value. They can over-value IP, and have difficulty in defining or valuing IP when it comes to public good research.

Rules over the ownership of IP are not clear. Everyone wants to own everything, from the scientist to the research organisations to the industry which commissioned the work. "We're so control minded that everything just gets blocked." It can be a problem when the person with the fire in their belly does not own the patent, or if they do own it but want to hang on to it too long. Some researchers have difficulty accepting a dilution in their control as the technology is developed towards a commercial product. Resolving internal ownership issues consume time and energy, and block the timely transfer of technology to a commercialising group. The ownership issue can obscure a larger point - the commercialisation issue.

Patenting is not necessarily the key issue on the road to commercialisation. Patents can be very expensive to register and defend, and taking out a patent should be a commercial decision. Sometimes patenting can impede dialogue and uptake of research. Confidentiality agreements may be the way to go, with patenting reserved for those things that are clearly worth defending.

Many researchers and technology transfer bodies lack the expertise to handle IP issues effectively. They need to accept that 10 per cent of a good idea which is being actively commercialised is worth more than 100 per cent of the IP of a good idea sitting on a university shelf. While the growing

awareness of IP can hamper relationships with industry and other researchers, ignorance of IP allows some individuals and organisations to give away their IP free to all-comers.

Recommendations from the group

- Encourage research organisations to trade control of IP for equity in commercialising companies, to take a more relaxed and flexible attitude to sharing control
- Create a funding source to enable research organisations to identify, protect and commercialise their IP, with a well-understood and well-supported system for control of IP on a national level
- Offer researchers and research organisations the option of owning equal parts of the IP
- Use think tanks to identify potential IP
- Use IP policies to provide incentives for individual researchers
- Allow scientists to take their IP when they create start-up companies, with the possibility of future benefits coming back to the research organisation if the company is successful
- Familiarise scientists with IP and commercialisation issues

Barrier 6. Australia's Taxation system

The Australian taxation system does not encourage investment in the commercialisation of new technologies. The system is not internationally competitive, and needs to offer more incentives to underline the basic attractiveness of Australia as a place invest in R&D and commercialise research results. Improved incentives should also serve to lift investment by Australian industry in R&D.

This generally unfavourable investment environment is encouraging companies to contemplate shifting their operations overseas to a more favourable tax climate. The system does not always offer support at the right time, and participants argue for more support at the 'D' end of the R&D equation. The system needs incentives at all levels, from local rates through State property taxes to Commonwealth taxation measures, perhaps with improved measures to guarantee quality control.

Venture capital and superannuation funds need to be encouraged to invest in high risk, high technology areas. The CGT system acts as a disincentive for foreign (as well as domestic) investors, notably US Pension Funds. "I was told I could get $50 million in 24 hours if we could change the tax laws." Reducing CGT will bring more money into the high-tech area, and drag it in at an earlier stage to help fill to 'funding gap' after research funding runs out but before commercial funds are prepared to risk their support. Making university companies exempt from CGT would be one way of encouraging start-up companies.

Once the correct settings have been achieved, a high degree of stability is seen as desirable to allow all participants to become familiar with the details of the incentive schemes. Participants feel that some schemes (such as syndication) have been discarded when it would be preferable to adjust and modify them. The issue of incentives needing to work in a complementary way rather than against each other was raised, with the example of the START scheme creating expectations and new embryonic technologies, only for the tax regime to drive these technologies overseas.

Recommendations from the group

- Reduce CGT to internationally-competitive levels
- Increase incentives to companies to undertake R&D, perhaps by restoring the tax break to a minimum of 150 per cent
- Offer incentives to venture capital and superannuation funds to invest in high-tech companies
- Improve taxation benefits to cover development as well as research
- Modify the system of tax deductibility so it operates with checks and balances rather than restrictive rules
- Extend the 125 per cent scheme so it applies to companies which invest in IP as well as owning it

Barrier 7. The funding gap and Government support schemes

The crucial gap in funding occurs in the development phase, after research funding runs out and before industry funding comes in. "There is a gap which is not currently being funded by anyone." Research organisations tend to underestimate or not take into account these costs; and lack of funding to take a research project through to the next stage can stop a project dead, especially when some research organisations and scientists consider the job is done when the work is published.
A small amount in additional funding can make a big difference, and figures from $10,000 to $200,000 were mentioned.

START grants do not always fill the gap because they require the involvement of an industry partner, often an SME (small to medium enterprise) without the resources to commit to the high cost of commercialisation or administration of the grant. Industry generally is more likely to be interested in a project which is close to market because of the high cost and long time frames of developmental work. The small size of Australian markets and the reluctance of industry to invest can exacerbate difficulties, driving good technology to seek a backer from overseas. Start up companies are a more likely vehicle for establishing the technology than existing companies.

Close relationships with industry from an early stage in the project can help gain support through the developmental stage, and in this regard, personal contacts are seen as crucial. SPIRT grants (meaning?) enable scientists to make effective links with industry people, and are generally approved.

A broadening of the possible uses of Government funds is seen as desirable. It is not possible, for instance, to get funding to do a patent search to discover what products are already in the market. Pre-competitive research is needed to establish the technology and determine the rate of return. It takes time for a group like a university technology transfer arm to build up a royalty stream which can then be applied on a discretionary basis for commercialising activities.

State bodies provide useful sources of funding (but can also act as regional obstacles).

Recommendations from the group

- Create a funding body to support commercialisation through untied grants or loans with low compliance costs, and with a component of long-term grants
- Rationalise Government programs (like Australian Postgraduate Awards (Industry) [APA(I)], START and SPIRT Awards), with simpler application processes, more than one funding round per year and fast-tracking of results
- Increase funding for Government programs like SPIRT and ARC, to enable SPIRT grants to be funded at full-cost and to provide additional support for basic research
- Provide Government assistance through grants or tax concessions for costs of commercialisation like the maintenance of patenting, developing a business plan, establishing a business network
- Create a START-like scheme which does not require industry to match government funding on a one-for-one basis
- Provide a database listing all Government support schemes in the area of commercialising science

Barrier 8. Cultural obstacles within research organisations

Scientists and research organisations are coming to grips with the demanding world of commercialisation, and the process is still at an immature stage. Research organisations are not industry-focussed, and some were reported as having no interest in commercialisation. Commercialising R&D is not seen as core-business: universities are more focussed on selling higher education overseas, with industry viewed as a cash cow rather than as potential partners.

Research organisations need expertise and a new flexibility and agility in dealing with the commercial world on issues like IP, attracting capital and industry-compatible salaries. Commercialisation has to become part of the culture and to be recognised throughout the organisations as being important. There is an expectation by industry and other technology users that they should not have to pay for research carried out in public good institutions because they have already paid for it as taxpayers; and this is matched by the lack of incentives or prohibitions to do otherwise by the research organisations.

Research organisations have to invent a whole new scale of merit based on commercial work rather than the traditional measure of judging publications. A number of questions need to be resolved: Can universities successfully blend a commercial and academic focus? Can standards and independence be maintained while they move closer to industry? Can successful examples of commercialisation be adequately rewarded, and an appropriate balance between fundamental and applied research be maintained?

There are mixed views of the value of the technology transfer arms of research organisations. Some are regarded as excellent, and others as passive or even a barrier, more intent on protecting their own interests than commercialising the work. CSIRO's commercialisation manual is reported as being more about control than encouragement. Some university transfer arms have little appreciation of the technology or the underlying concepts. At times there is an expectation that scientists will know it all and can do it all - legal, patents, venture capital, marketing, business plans. Technology transfer arms need their own sources of funding so they can move quickly in response to industry needs.

Research organisations invest huge amounts in applying for grants under systems with an 80 per cent failure rate, yet seem reluctant to put resources into commercialisation where potential returns are probably higher. They are conservative and risk-averse, and this hinders commercialisation - academics are not accustomed to the failures that occur in the business world.

Recommendations from the group

- Promote properly resourced and trained technology transfer units within research organisations, more orientated to industry and able to see commercial possibilities
- Encourage greater interaction between research organisations and industry through forums, open days and student placements, to encourage the speaking of a common language
- Develop a flexible system covering the employment and rewards for scientists within research organisations
- Encourage a team approach in universities through imaginative reward structures, to enhance commercialisation
- Build entrepreneurial incubators and mentoring groups around universities, to encourage a more commercial outlook and provide assistance to scientists engaged in commercial activities
- Create new courses which cross traditional disciplinary boundaries, to encourage a mixing and flowing of ideas (the chaotic model)
- Place science innovation technologists within research organisations to identify and commercialise promising ideas (as at the Garvan Institute)
- Fund more CRCs to build awareness among scientists of what commercialisation is all about

Barrier 9. Cultural gaps with industry

Australian industry does not have the vision to look ahead 20 or 30 years, to see the "new" technology. It tends to be timid about exploring new opportunities and reluctant to stretch itself financially. Industry prefers proven ideas from overseas to innovative home-grown solutions, and reflects a community view focussed on stability rather than opportunity. Commercialisation is inhibited by the fragmented nature of industry in Australia.

Industry generally views money spent on R&D as a cost, not an investment. Companies prefer to put money in low risk, short-term ventures, with research focussed directly on a specific product rather than its long term future. Larger companies are reported as wanting the technology on an "all or nothing" basis, with no chance of further collaboration. Industry (as well as other sectors) are seen as intolerant of failure, even though only a small proportion of ideas will succeed and failure can be a valuable learning exercise.

Shareholders concentrate on immediate profits rather than long term growth, which leads some companies to disguise their expenditure on R&D. The overall level of investment in R&D by industry is low by international standards. At the same time, scientists can underestimate the time and cost of the development phase; and there needs to be a better appreciation of the risks on both sides.

More competitive companies are emerging in the form of spin-offs formed by scientists leaving their research organisation. This is leading to a more positive attitude to investment, particularly in areas like biotechnology. These SMEs are easier to deal with than bigger companies with their own bureaucracies. They have fewer resources to put into R&D, but they are more willing to take risks and less likely to bog down discussions with lawyers.

Industry managers tend to have an incomplete understanding of the technology and its implications. Companies may not employ a person with adequate research experience and technical understanding (and the authority) to progress the work and assess the results. Industry finds it hard to keep up with changes in Government policies and funding schemes.

International companies are seen as providing funding for R&D and distribution networks, particularly by the researchers looking to fill niche markets. Some Australian companies act primarily as the agent for an overseas company.

Recommendations from the group

- Involve industry and market people in research projects at an early stage
- Increase Government incentives to boost investment by industry in R&D
- Encourage industry to interact with research organisations, and to serve on Boards of R&D groups
- Help investors make hi-tech investments, through education and advice and mechanisms which enable them to spread their risk
- Educate industry (and other communities) to accept failure as a valuable and unavoidable part of commercialisation
- Change research emphasis from laboratory experiments to doing industry trials
- Develop the alumni system of the US to build linkages between industry and research
- Establish a program to sell the advantages of doing research in Australia

Barrier 10. Cultural gaps with Government

Government is perceived as not appreciating the value of new technology for economic growth (unlike governments in the UK, Japan and the USA), and politicians as being uninterested and poorly-informed on S&T matters. Participants feel that the science portfolio does not enjoy a very high status. Politicians generally regard research as a cost against the public purse rather than an investment in the future, fundamental to Australia's future. Government is risk averse and not active in encouraging new technology or supporting S&T, although the emergence of innovation policies from State governments is seen as a positive sign.

The science community needs to make a bigger effort in communicating the benefits of its work, particularly with MPs with influence in key areas of Finance and Treasury. Participants recognise that it can be difficult to produce figures to show the benefits of investing in research, and that inadequacies in the collection of official statistics are not helpful.

Government has a major role in setting the climate and the framework for the commercialisation of R&D. It could take a leadership position in helping change negative community attitudes about the value of science and its role in wealth creation. It could also set a more positive environment for innovation and the entrepreneurial spirit, and the benefits of a long-term approach. It needs to develop a policy agenda and a strategy with long-term goals, although the three-year election cycle militates against this. Government should adopt a more encouraging attitude. All the messages from Government are that S&T is not a good career path.

Support for research should be bi-partisan, to maintain stability and familiarity with funding schemes and to get away from boom-bust cycles. Neither the science community nor industry are confident about the continuation of Government programs in support of research. The advantages of Australia as a safe and stable community in which to conduct R&D could be promoted more vigorously. Australia could be painted as "a land of opportunity".

Participants had mixed responses to bureaucratic support for Government schemes supporting R&D. Some report helpful advice for dealing with START, SPIRT and AusIndustry applications; and others complain about a level of paperwork and complexity such that it is hardly worth applying. It is seen as very useful to work closely with Government officers. The programs themselves are hindered

by poorly informed bureaucrats and the rapid turnover of key personnel; and the programs can be slow and inflexible.

Recommendations from the group

- Assist Government to develop a policy agenda which accepts R&D and commercialisation as central planks of a national economic policy with a 20 year perspective
- Encourage a more entrepreneurial spirit in Australia through policy settings and an education campaign
- Encourage the science community to sell the benefits of investing in R&D to Parliamentary members, to develop bi-partisan support for the long-term funding of research
- Establish or maintain S&T representation in embassies, to sell Australian science
- Build greater consistency and flexibility in Government funding schemes
- Revamp taxation and incentive measures to encourage the development of products in Australia through support to industry in pre-production period

Barrier 11. Cultural obstacles within the Australian community

Australians do not appreciate the benefits of investing in research and the opportunities that investment in these areas can bring. Our society is not innovative and our culture is risk-averse when it comes to science. We do not accept that research sometimes fails, in contrast with the American view that values failure as an important learning experience. The Australian community does not appreciate the connection between science and technology, and a healthy long-term economy.

Australians lack confidence in the talents and inventiveness of their fellow-countrymen, and tend to look overseas for solutions. "While we believe our sporting champions can compete with the world's best, Australia sends wool to Italy to be made into suits." The concerns that the community has over science ideas lost overseas needs to be translated into preventative measures. The innovation process has to be "owned" by the community.

We need to celebrate our successes so that scientists are valued household names. Australia lacks role models of prominent entrepreneurial scientists. American media regularly features scientists who have become commercial successes, unlike our media. The shortage of qualified science teachers has ramifications throughout the system, and particularly on the attitude of people to science and technology.

The science community should not rely on Government to sell its message, and needs to work together and take responsibility on the benefits of research and innovation. Scientists should be ruthless when it comes to educating and informing the community about science issues. They also need to recognise the danger of over-selling the benefits of research, and must be careful to give a realistic assessment.

Recommendations from the group

- Educate the community to appreciate the benefits, the real returns (and risks) of research
- Put more resources into communication of the benefits and problem-solving capacity of research, an education program which will celebrate our successes and champions
- Educate children (and the community) that it is acceptable to be innovative and entrepreneurial
- Train and employ more qualified science and maths teachers for school children
- Increase the mobility of scientists between industry and research organisations

The positive side: Australian stories of success

The major focus of the discussions was on the impediments which hindered scientists and technologists in their efforts to commercialise their work. As well as being invited to identify the impediments and their solutions, the participants were asked to nominate systems or organisations which worked well. The following section summarises their response.

Cooperative Research Centres

CRCs have helped change the research environment, with their focus on industry links, commercialisation and training of post-graduate students. They have forged new partnerships between the users and the providers of research, involving both sides from the earliest stages of planning.
They have cut across boundaries and broken up existing territories; and at their best, they display a flexibility and commercial focus which contrasts with the outlook of Australia's traditional research organisations.

Their commercial focus make them a ready source of continuing advice for scientists with potentially commercialisable research. The CRCs have dramatically improved the quality of advice on commercialisation, as well as bridging the cultural gap between research and industry. It is easier to protect IP and engage in commercialisation through a CRC than other research organisations. The new emphasis on "doing it together" means more industry plant trials than lab experiments. Industry representatives on the boards of CRCs are helping bring a different focus to the research, and the experience of making researchers face up to industry-based Boards is dynamic. CRCs have in some cases been able to help commercialise new ideas by filling the funding gap identified earlier.

CRCs are able to provide both researchers and industry with a stable environment to commercialise, with a seven year life span. They can create the critical mass to operate after government funding ceases, although early hopes of independence after seven years have taken a nosedive. Respondents were critical of the artificial requirement that only "new" CRCs could apply for funding, when it takes two seven-year rounds to make things happen.

The CRC world is not a perfect one. Their quality is variable and their formal structures can lead to tensions through different cultures in the partners. There are organisational difficulties on matters like promotion when people working for a CRC are employed through a university or CSIRO; and there is some scepticism about excessive spending on administration. But overall the picture is a positive one.

Other schemes and programs
A significant number of participants report good experiences of systems and organisations operating in Australia, although these experiences are by no means universal. The SPIRT scheme is recognised as offering valuable support for young researchers gaining experience in industry while undergoing their postgraduate training, with some regrets expressed that the number of grants was not sufficient to meet demand.

The START scheme was also supported, although clearly scientists would like the application process to be less onerous and less formal. They suggest more funding rounds per year and see value in being able to offer a similar scheme with a relaxation on the requirement that industry provides 50 per cent of the funding.

Some of the commercialisation arms operated by universities drew praise for the advice and assistance they are able to offer scientists, but these were in a minority. "UniSearch were great to deal with. They gave excellent business advice and had excellent negotiating skills." A more common view is that not enough of the staff of these units have the skills or the experience to be handle all the issues the commercialisation process can generate, and that the consolidation of these units into fewer larger centres of advice would be helpful.

The program of the University of South Australia to provide mentor links and pro bono advice to help people create their own companies was recognised, as was its incubator model which throws together young scientists from different disciplines to provide a dynamic mix ("chaotic groups").

Other systems which were mentioned in a positive light included support by superannuation funds for National Health and Medical Research Council (NH&MRC) projects and the Rothschild Biotechnology Fund. These were offered as models for schemes that could be introduced across all disciplines. The Rothschild Fund is reported as "trawling through universities looking for good ideas", and all these approaches could be taken up across the sciences.

Overseas examples

In the US there has been a backlash against lecturers spending all their time chasing research dollars rather than being involved in education, so that when promotions are considered in some institutions the first category is teaching, then university service, then research. Commercialisation is considered under the heading "university service".

There was some support for the American practice at some research institutions of allowing staff to earn funds above their normal salary for up to three months each year, normally through consultancy agreements with industry. Participants see this as assisting in establishing the crucial linkages between industry and research organisations, and making the process of crossing from one organisation to another, and then back again much easier. The American practice of scientists leaving their research work to champion the commercialisation of their work is made easier by the fact that the route back again is easier than in Australia.

In the US there are many innovative and creative win-win linkages between small companies and large strategic partners. While there is no blueprint to this, there are examples of pharmaceutical companies "grazing" on the innovations from small start-ups and research groups as the source of their new product ideas. US companies acquire technology through takeovers of small innovative companies.

A fruitful structure in the US for developing ideas are the "chaotic groups". These groups have to achieve a critical mass, and consist of young scientists from different disciplinary backgrounds, together with people from industry and "cowboys" (a scientist with a commercial bent and technological knowledge, not necessarily a top researcher but one willing to cut corners and usually regarded as a loose cannon).

Israel offers support from the birth of an idea. This support is offered by a team combining expertise in areas like marketing, finance and technology placement. Their incubator model is a screened process which trains inventors in business skills, development of business plan and other commercially-related activities. Essentially the program offers mentors and funding (a grant of $50-100,000 pa for two years); and since 1990 it has generated 2,400 start-up companies and significant amounts of venture capital.

Other US systems which drew praise were:

- the alumni system linking industry and researchers, and providing good sources of advice and expertise
- local incentives (land tax rebates, help with infrastructure) to attract spin-off companies
- flexible terms of employment which allow staff to run a company while supervising postgraduate students
- sophisticated marketing tools
- exposing graduates routinely to people who have developed commercial products
- cooperative working together of companies (particularly the SMEs)

European models suggested by participants were the way the Swedes and Finns value their people, in contrast to the Australian attitude of valuing its natural resources more than its human resources. The Germans support long-term research through Government grants, and German industry is heavily involved in getting the best ideas from universities, in contrast to the lack of activity on the part of Australian industry.

Conclusion

Scientists and technologists recognise that Australia has much to gain by successfully commercialising more of its science. Generally they are prepared to be part of this process - a fact indicated by the willingness of so many of them to be part of these discussions - but have found many obstacles in their attempts. Some have managed to achieve success or partial success, while others have given up the unequal struggle to concentrate on more traditional paths to academic success.

The term "culture change" kept recurring in the focus group discussions. Clearly scientists think that things have to change, and that all groups and individuals involved in the process (including themselves) need to work at building new relationships and new systems in order to encourage commercialisation. They recognised the process of cultural change has begun, although commercialisation in Australia is at an immature stage and lagging behind practices and effectiveness evident in other parts of the world.

The recommendations, suggestions and models set out above are possible actions for all parties involved in the commercialisation of Australian science and technology. They suggest courses of action for industry, for Government, for universities and other research organisations, for the sources of capital, and for the scientists and technologists themselves. These recommendations are a contribution to a dynamic process already in train, of strengthening the commercialisation of Australia's science.

Appendix One List of participants in the focus groups

Brisbane Focus Group, 12/10/98 at 10am
David Noon, CRC for Sensor Signalling and Processing
Margaret McGrath, CRC for Mining Technology and Equipment
Lisa Daniel, Qld Agricultural Biotech Centre
Scott Newman, CRC Meat Quality
Don Kakadu, Forbio Research
David Fairbairn, Forbio Research
John Pittendreigh, CSIRO Exploration and Mining
Bea Duffield, Qld Department of Primary Industries
John Barry, University of Qld
George Paropat, CSIRO Exploration and Mining
Jacek Charbucinski, CSIRO Exploration and Mining

Brisbane Focus Group, 12/10/98 at 1pm
Banalu Wijesinghe, Qld Department of Primary Industries
Adrian Vos, Qld Department of Primary Industries
Claire Winkel, Qld Department or Primary Industries
Peter Bundeson, CRC Distributed Systems
Gordon Dunlop, CRC for Alloy Steel Technology
Paul Ebert, University of Queensland

Townsville Focus Group, 13/10/98 at 12pm
Don Alcock, CRC Reef
Bevin Williamson, James Cook University
Lyndon Llewellyn, Australian Institute of Marine Science (AIMS)
Peter Murphy, AIMS
Bill Pierce, James Cook University (JCU)
Jim Burnell, JCU
Keith Kikkert, JCU
Peter Isdale, AIMS

Sydney Focus Group, 29/10/98 at 10.15am
Ken Doolan, University of Western Sydney, Macarthur
Iain Mason, University of Sydney
Alister Sharp, CSIRO Food Technology
Kevin Broady, University of Technology, Sydney (UTS)
Joe Unsworth, UTS
Geoff Smith, UTS
Simon Tout, University of NSW (UNSW)
John Rodger, Marsupial CRC
Tony Weiss, University of Sydney
Lee Ridge, CRC Waste Management
Warwick Dawson, UNSW
Robert Lamb, UNSW
Peter Montague, Aquaculture CRC
David Walsh, UNSW

Sydney Focus Group, 29/10/98 at 1.15pm
Cris dos Remedios, Institute for Biomedical Research, University of Sydney
Paul Compton, University of Sydney
Robert Dale, Microsoft Research Institute, University of Sydney
Adrian Lee, UNSW
Bob Steele, CSIRO Food Science
Bob Jansen, CSIRO Maths and Information Science
Peter Bergquist, Macquarie University
Keith Williams, Macquarie University
David Nathan, The Warren Centre

Melbourne Focus Group, 2/11/98 at 10am
Stephen Hawkins, CSIRO Wool Technology
Martin Robson, Martek International, Pty Ltd
Stephen Hodson, Aquaculture CRC
Paul Wood, CSL Ltd
Michael Chapman, CSIRO Science Education
Jim Cull, Monash University
John Grandfield, CSIRO Manufacturing Science and Technology
Geoff Prince, La Trobe University
Tony Balic, University of Melbourne
Jan Thomas, Federation of Scientific and Technological Societies

Melbourne Focus Group, 2/11/98 at 1.15pm
R. Shepherd, La Trobe University
B. Pham, University of Ballarat
W. Sawyer, University of Melbourne
C. Crisafulli, Technology and Innovation Management
C. Chantler, University of Melbourne
C. Chipperfield, Australian Mineral Exploration CRC

Melbourne Focus Group, 2/11/98 at 3pm
George Riffkin, Victorian Department of Natural Resources and Environment
Peter Scammells, Deakin University
Graham Thorpe, Victorian University of Technology
John Allen, Victorian University
Rob Capon, University of Melbourne
Angeline Bartholomeusz, VIDRL
Mike Murray, CSIRO
Peter Gipps, CSIRO
Doug Hawley, CRC for Industrial Plant Biopolymers
Roy Jackson, Monash University

Canberra Focus Group, 5/11/98 at 11am
Ron Jackson, CSIRO Wildlife and Ecology
Bob Seamark, CRC Vertebrate Biocontrol
Greg Ryan, Ecowise Environmental
Helen King, Fisheries R&D Corporation
Paul Hutchinson, CSIRO Land and Water
Brad Sherman, CSIRO Land and Water
Brian Corrie, Australian National University (ANU)
Helen Wilson, Department of Industry, Science and Tourism
Andrew Holt, Canberra Inventors Association

Canberra Focus Group, 5/11/98 at 2pm
Ted Maddess, ANU
Murali Nayudu, ANU
Ian Williams, ANU
John Thompson, ANU
Anne Campbell, CRC Association
Lex Beardsell, Anutech Pty Ltd
Bob Bitmead, CRC for Robust and Adaptive Systems
Michael Holland, Vertebrate Control CRC
David Fayle, BioAccent Pty Ltd
Peter Vallee, Academy of Australian Science

Adelaide Focus Group, 25/11/98 at 10am
David Topping, CSIRO Human Nutrition
Jim Fortune, CRC Weeds
Rob Morrison, Anti-Rabbit Foundation of Australia
Brian Dean, Mental Health Research Institute

Mark Seeliger, CRC for Soil and Land Management
Kim Bryceson, CRC for Soil and Land Management
Bruce Munday, National Dryland Salinity Program

Adelaide Focus Group, 25/11/98 at 1pm
Ian Ferguson, Flinders University
Wendy Jones, University of Adelaide
Steve Tyerman, Flinders University
Graham Gurr, University of South Australia
Robert Rush, Flinders University
Ian Davey, University of South Australia
Bob Woodbury, South Australian Research and Development Institute (SARDI)
Bob Taylor, Techsearch Inc
David Corkindale, University of South Australia

Perth Focus Group, 2/12/98 at 9.30am
Howard Carr, The GIS Lab
Louis Moresi, CSIRO Exploration and Mining
Michael Borowitzka, Murdoch University
Mathew Wilce, University of Western Australia (UWA)
Jackie Wilce, UWA
Chris Isaac, CRC for Broadband Telecommunication and Networking
Lynnette Chester, CRC for Broadband Telecommunication and Networking
Giles Thomas, Australian Mineral Exploration CRC
Steve Thurgate, Murdoch University

Perth Focus Group, 2/12/98 at 1pm
Helen Robertson, Perth Zoo and Marsupial CRC
Brian Plewright, Curtin University
Graeme Yates, UWA
Erik Kelmerhorst, Curtin University
John Barker, WA Department of Commerce and Trade
Nancy Longnecker, CRC for Legumes in Mediterranean Agriculture
Simon Langton, Murdoch University
Len Warren, CSIRO Minerals