Inquiry into pathways to technological innovation

House of Representatives Standing Committee on Science and Innovation

CSIRO submission

29 April 2005

Contact: Zack Herlick, General Manager Growth Partnerships
CSIRO Corporate Business Development & Commercialisation
5 Julius Avenue, North Ryde NSW 1670 Australia
Tel: 02 9490 8184
Email: zack.herlick@csiro.au

Acronyms used

AGP	Australian Growth Partnerships
BITS	Building on IT Strengths
CCST	Coordinating Committee on Science and Technology
COMET	Commercialising Emerging Technologies
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CST	Client Service Teams
DCITA	Department of Communication, Information Technology and the Arts
GDP	Gross Domestic Product
HECS	Higher Education Contribution Scheme
IIF	Innovation Investment Fund
IP	Intellectual Property
PDF	Pooled Development Fund
PFRA	Publicly Funded Research Agencies
PSF	Pre-Seed Fund
QEM*SEM®	Quantitative Evaluation of Materials by Scanning Electron Microscopy
R&D	Research and Development
SME	Small to Medium Enterprise
VCLP	Venture Capital Limited Partnership
VCs	Ventura Capital Fund Managers
VICCU™	Virtual Critical Care Unit

Table of contents

Executive Summary

- The words "innovation", "commercialisation" and "technology transfer" carry different connotations for different people.

Technology transfer pathways

- CSIRO creates benefit for Australia through the application and utilisation of the results of its scientific research and development.
- CSIRO is therefore deeply engaged in technology transfer and the many pathways to successful commercialisation.
- The innovation process has many pathways to commercialisation from a CSIRO context that include:
  - Publishing the results of research, publishing scientific papers, providing scientific input into policy making, contract research, providing technical services and consulting services, joint ventures and co-investment arrangements, licensing intellectual property and spinning-out new start-up companies.
- The needs of the industry or community partner are a key driver to appropriate choice of a particular pathway. Client service teams and "challenge workshops" have been effective tools for CSIRO's market driven work with large corporate clients in particular.
- The success of any technology transfer is also driven by relationships and interactions between people. People who have experience in both an industry and a research organisation can be especially effective at bridging the divide.
- Technology transfer is not a linear process and often involves iterations and may take many years to achieve impact.

SMEs and innovation

- SMEs are the growth engine of the Australian economy and provide an important vehicle to translate innovation into market impact.
- Many technology-based SMEs have high potential to benefit from working with PFRAs and other research organisations. Collaboration is the oxygen of innovation.
- Much policy attention is placed on the creation of spin-offs and providing assistance to small start-up SMEs as a pathway to commercialisation. Under-resourced spin-offs cannot sustain themselves and have little chance of surviving.

CSIRO's engagement with SMEs

- CSIRO is focusing on generating fewer, but larger and more sustainable spin-off companies that have critical mass and are well positioned to thrive.
- Most engagements between SMEs and publicly funded research agencies (PFRAs) or universities are for small scale incremental projects that do not meaningfully boost the SME's opportunities for growth.
- In order to make it easier for SMEs to engage with CSIRO, CSIRO has launched the *FastTrack* contract simplification system, which has been welcomed by SMEs.

Impediments to collaborations

- An opportunity exists for PFRAs and universities to engage with high potential SMEs on large scale, deep collaborations that will accelerate the growth of the SME leading to increased exports and job creation.
- However, there is a structural gap that is preventing these large collaborations from taking place:
  - Even successful SMEs struggle to afford investing in their ongoing innovation and commercialisation.
  - PFRAs and universities do not currently have the financial flexibility to subsidise collaborative projects with SMEs.
  - Existing mechanisms of funding collaborations do not go far enough.

Pathways to technological innovation: Suggested priority improvement measures

- Possible improvement #1: Australian Growth Partnerships (AGP) is a proposal to selectively fund high potential large scale collaborations between star SMEs and research providers.
- Possible improvement #2: Encourage widespread adoption of contract simplification such as CSIRO's *FastTrack* program to make it easier for SMEs to engage with PFRAs and universities and drive out transaction costs.
- Possible improvement #3: A mandate to PFRAs and universities to encourage an additional focus of resources on collaborations with SMEs, which may require additional funding to facilitate the interactions.
- Possible improvement #4: Increased prioritisation on people development that creates a strong and varied experience base and diminishes the divide between industry and researchers.

Additional suggested improvements

- Possible improvement #5: The creation of a new government funded program, similar to the Pre-Seed Fund program, but focused on SME-PFRA and SME-university collaborations could help close the gap.
- Possible improvement #6: A "carve-out" from Commercial Ready tailored to SMEs engaging in large-scale collaborative projects and waiving the requirement that SMEs put up 50 percent of the costs.
- Possible improvement #7: Additional government support for key market facing "solutions clusters" would help facilitate deeper collaborative engagements with SMEs as well.
- Possible improvement #8: Increased awareness in the marketplace of current assistance programs would benefit SMEs.
- Possible improvement #9: A clear outcomes framework with regards to SMEs might help guide PFRAs and universities.
- Possible improvement #10: Additional support for intermediaries, brokers and facilitators could benefit a wide range of SMEs.
- Possible improvement #11: Line funding of technology transfer offices of PFRAs and universities might foster better industry linkages and further support the critical "third stream" knowledge transfer activities of universities and PFRAs.

Conclusions

- CSIRO is focused on ensuring the greatest impact possible from its investment in science. Science for science's sake is insufficient. To have the greatest impact, CSIRO needs to ensure that the models and methods adopted for transferring technology to the ultimate adopter are as effective as they can possibly be. This is an area where there are no hard and fast rules. What may work for one industry sector may not work for another. What works for one type of research may not work for another. It is highly dependent on the individuals and organisations that operate within each space.
- Ultimately, technology transfer is all about people engaging with other people. Working out how best to communicate requires careful thought in each circumstance. Importantly, effective technology transfer is not all about the number of patents or spin-offs created. It is also not about the amount of value that is captured along the way. It is mainly about impact – the amount of value that is ultimately generated for Australia by diffusing and transferring research and development outcomes to the right parties at the appropriate time in the most effective way.
- SMEs, in particular, are important vehicles for innovation to have impact in Australia. There are currently structural barriers that impede SMEs from easily accessing the rich catchments of innovation in Australia's PFRAs and universities. By removing these barriers, Australian SMEs would have an additional opportunity to continue to stay ahead of their global competition. CSIRO is eager to help make that happen.

Why does CSIRO regard pathways to technological innovation as important?

CSIRO's purpose is: "By igniting the creative spirit of our people we deliver great science and innovative solutions for industry, society and the environment". For the last 80 years, CSIRO and its predecessors have been at the forefront of science and innovation to deliver impact for Australia. CSIRO continues to build on this foundation today and into the future. Through quality and leading-edge science, the organisation helps push back the frontiers of science, brings about long-term transformations and applied practical solutions to benefit Australian industry and the community at large.

CSIRO seeks to maximise the benefit to Australia from the technology it develops. To that end, CSIRO seeks to constantly improve the pathways from discovery to commercialisation. CSIRO strives to maintain relevance and impact for Australia and to offer a differentiated value proposition in terms of its size, scale and multi-disciplinary capabilities for R&D. The private sector is often best placed to take innovations forward into products or services that can be distributed locally and globally.

Impact is CSIRO's aim and the organisation measures it in several ways. Impact is achieved through the application or utilisation of the results of scientific research to help build innovative and competitive industries, a healthy environment and lifestyles and a technologically advanced society. This requires creating relevant solutions for Australia with a relentless commitment to effective knowledge transfer and diffusion. CSIRO works just as hard at bringing its science into Australian communities and industries as it does at creating that science. CSIRO helps create new industries, influences policy, drives innovation, provides testing services and increases the awareness of science in the nation.

Much of Australian industry relies on continued innovation to remain globally competitive and only remains differentiated and competitive where innovation leads the way. However, it is not just innovation itself that is important. The choice of appropriate pathway to commercialisation and technology transfer is critical. Publicly funded research agencies (PFRAs), such as CSIRO, play an important role in helping to provide pathways for technology transfer. The choice of pathway differs depending on the type of science and the particular context of the partner or customer. Selecting the right approach to technology transfer ensures that any new knowledge developed in a publicly funded research organisation can reach the most appropriate recipients in the most timely manner to maximise the impact for Australia – for both society and the economy.

The words "innovation", "commercialisation" and "technology transfer" carry different connotations for different people. "Innovation" within a CSIRO context, is an overarching process that incorporates a wide range of activities from discovery through to commercialisation – innovation is a much broader concept than the mere discovery of a novel technology. Ideas or discoveries must be successfully exploited through appropriate commercialisation in order for innovation to have impact. Innovation is an iterative process, driven by people collaborating to solve a problem or exploit an opportunity. Commercialisation and other forms of technology transfer are important steps in the innovation process. Research, development, collaboration and technology transfer are all important components of the process of successful innovation.

Many pathways from discovery to commercialisation

CSIRO is increasingly an outwardly focused organisation that is conscious of the importance of partnerships and external engagement and connectivity. Much of CSIRO's activities involve working closely with industry and the community to proactively facilitate pathways from discovery to commercialisation, respecting the sense of urgency felt in most industries. Through their application in industry or the community, the development and application of relevant technologies can create jobs, build economic value and improve life for Australians. Depending on the context, there are a wide range of possible pathways to facilitate successful commercialisation. Some relevant examples of pathways from a CSIRO context include:

- CSIRO signs around 150 new *licences* a year for its intellectual property to a wide range of small, medium and large companies and community organisations. Some licences are

exclusive and some are non-exclusive, encouraging a wide adoption of useful intellectual property. Overall CSIRO revenue from intellectual property last year was $22 million, a 60% increase on the previous year.

- CSIRO engages in market driven *contract research* with a wide variety of clients from across industries, communities and geographies. CSIRO generates about 8,000 client reports per year. CSIRO's clients span many different countries – CSIRO has been involved in over 700 engagements outside Australia with international collaborators. Much of CSIRO's domestic contract research work is done in partnerships with SMEs (see discussion p.10). CSIRO generates approximately 2,000 contracts with SMEs per annum.
- CSIRO partners with industry and the community in *joint ventures and co-investment* arrangements. One recent example includes CSIRO Petroleum Resources, Curtin University of Technology and the University of Western Australia's strategic partnership with Woodside Energy Ltd, with Woodside committing $30 million to fund oil, gas and other energy R&D projects.
- CSIRO provides a range of *technical services* and *consulting services* to companies who are themselves commercialising innovation. As an example, CSIRO's Fire Testing Service is the most comprehensive fire research, consulting and testing facility in Australia that is capable of simulating a wide range of fire scenarios.
- CSIRO periodically commercialises intellectual property through the creation of *new spin-offs and start-up companies.* But CSIRO endeavours only to spin-off companies that have a strong opportunity to be sustainable independent companies with sufficient market opportunity, technology and management to withstand the challenges of a globally competitive marketplace. *Intellection* is a recent example and is the global leader for rapid, automated, quantitative evaluation of minerals, rocks and man-made materials using the fastest and most productive microbeam mineral analysis system in the world. Intellection was launched by CSIRO in October 2003 after 20 years of comprehensive and rigorous scientific research and discovery, to better market, develop and support its unique mineral and material analysis technology.
- CSIRO publishes the results of scientific research widely, around 4,000 *scientific papers* per year in academic journals and other vehicles meant to broadly disseminate scientific information and outcomes, as well as over 200 media releases per year. This diffusion of scientific outcomes to the broader scientific community is a pathway for innovation to contribute to the global knowledge base even though it may not be commercialised directly.
- CSIRO provides a wide range of *scientific input into government policy debates* that can help inform the creation of policies based on scientific evidence and information. This contribution to policy debates may help to shape the commercialisation efforts of others. From 2003 to 2004, CSIRO made more than 20 submissions to Commonwealth and State government inquiries and a large number of parliamentary briefings and conferences covering a broad range of topic areas. The upcoming Greenhouse 2005 conference in November is a current example. Greenhouse 2005 will draw together the current knowledge of climate change to present as complete a picture as possible of the known impacts of climate change in Australian cities and the natural environment, and how Australia needs to proceed to respond to these changes. Greenhouse 2005 is being organised by CSIRO in collaboration with industry, government and universities.

The appropriate choice of a particular pathway depends on the particular industry as well as a wide variety of other factors, most important of which are the particular needs of the industry or community partners.

While choice of pathway is important, relationships and interactions between people ultimately drive the success of any technology transfer pathway. Technology travels on two legs. It is only through the deep engagement of people collaborating and interacting that technology transfer occurs. Deep relationships, know-how and personal networks underpin nearly all successful commercialisation pathways. People who have experiences both from industry and from within a research organisation

can be especially effective at bridging the divide. Encouraging even more interactions between researchers and people from industry through secondments, joint appointments and other mechanisms could greatly improve technology transfer across the board.

Furthermore, technology transfer is not a linear process and often involves iterations. Roadblocks in a particular development pathway often require additional research and exploration. Similarly, research that is initiated with delivery pathways in mind often has a better chance of being commercialised and ultimately having impact. The National Research Flagship model of deep engagement with industry from inception is an example of linking discovery through to commercialisation right from the beginning of the innovation process.

Some models of engagement with large corporates are delivering impact

Over the last several years, CSIRO has been initiating a client service team (CST) approach with certain clients. This approach offers coordinated relationship management while still harnessing the diversity of capabilities within an organisation as multi-disciplinary as CSIRO.

CSIRO has also been initiating "challenge workshops" with large domestic and multinational corporates to get a sense of the top challenges facing large companies and then determining where CSIRO capability might help.

Both CSTs and challenge workshops focus attention on the needs of the client (market pull) as opposed to the science that CSIRO may have developed (science push). Such a strong market pull orientation has led to a wide variety of successful contract research projects as well as co-investment opportunities with large companies. CSIRO's relationship with BOC Group is a recent example of this approach at work. BOC Group is an industrial gas company that worked collaboratively with CSIRO to identify a replacement for a gas that is banned by the Montreal Protocol because of the damaging effects on the ozone layer. Through the CST approach and the challenge workshop methodology, an alternative gas was identified for BOC from within CSIRO's Entomology Division.

It is also imperative that PFRAs and universities work closely with SMEs

SMEs are the growth engine of the Australian economy. They make a disproportionately large contribution to economic growth, exports and to industrial development in Australia. They have accounted for 70 percent of jobs growth over the past decade and contribute approximately 30 percent to Australia's GDP. Not only are SMEs intrinsically important to Australia, but they are also a natural vehicle to translate R&D into market impact. SMEs are an important distribution channel, or pathway for Australian science to have impact.

It is worth noting, however, that not all SMEs are appropriate R&D partners, or commercialisation pathways, for an organisation such as CSIRO. In Australia, an SME is any company with less than 200 employees. There are three distinct categories of SMEs. Of the 1.2 million SMEs in Australia, approximately half are sole proprietorships or non-employing companies. Of the 600,000 SMEs in Australia that employ between one and 200 employees and are pursuing economic growth, there are two types. Certain SMEs pursue success through marketing, sales and distribution of services or someone else's products. These SMEs may be quite innovative in their systems and processes, but are not typically science and technology-based innovators. R&D is not as relevant for this class of SME. There are, however, a substantial number of SMEs across a wide range of industries that pursue economic growth through applied innovation that builds from R&D. These technology-based SMEs in particular have high potential to benefit from working with PFRAs and other research organisations.

A great deal of attention is currently paid to the creation of spin-offs as a pathway to commercialisation

One frequently utilised model of commercialisation is to perform research that generates intellectual property, and then create a corporate structure around that IP and seek early stage funding for the new spin-off.

Strong government support already exists for spinning innovation out into new start-up companies. Government funded programs such as AusIndustry's COMET (Commercialising Emerging Technologies) program and the Pre-Seed Fund Program provide a strong boost of business assistance and capital for such start-up companies. Government programs such as DCITA's Building on IT Strengths (BITS) incubators help to facilitate the creation of technology-based start-up companies. The recently launched Commercial Ready Program provides critical leverage to young SMEs which are bringing innovation to market. Recent reforms in venture capital legislation (VCLP) provide tax incentives for overseas investors in Australian start-up companies. Programs such as the Innovation Investment Funds (IIFs) and Pooled Development Funds (PDFs) also increase the supply of capital to start-up and spin-off Australian SMEs.

Arguably too much attention is placed on the creation of spin-offs as a pathway to commercialisation, given the challenges that spin-offs face in the marketplace

Stimulating spin-offs is important, especially if those spin-offs are well positioned for success. The recent 15 April 2005 report to the Coordinating Committee on Science and Technology (CCST) regarding metrics for research commercialisation points out that Australia's system of research commercialisation metrics "focus[es] on indicators of activity and process, with little attention to outputs and outcomes". This is particularly true with regard to the historical emphasis on measuring (and therefore encouraging) the creation by PFRAs and universities of large numbers of small spin-off companies. A key metric of success for PFRAs and universities has always been the number of spin-off companies. However, quality is much more important than quantity when it comes to creating spin-offs. Spinning-out a technology is just the beginning of a successful commercialisation process. Substantial challenges await small start-up companies which compete without strong product differentiation, market focus, funding, management talent, and sales and marketing capability. Under-resourced spin-offs can not sustain themselves, they cannot attract serious leadership and they have very little chance of surviving. Spin-offs that are under-resourced or positioned poorly for market opportunities will often fail.

Significant progress has been made at CSIRO in the last few years towards fewer, but larger and more sustainable spin-offs that have critical mass. Spinning out a set of technologies into a new start-up company makes sense as a viable pathway to commercialise innovation only under certain circumstances. It is most appropriate when such a stand-alone company has a robust technology portfolio, well positioned products or services, appropriate funding to execute on a business plan, and a strong management team in place. Recent examples of this model of high-potential spin-off companies from CSIRO include Intellection, WindLab Systems, Polynovo Biomaterials, and BetaBiotics (see case studies in Appendix 1). CSIRO has worked diligently to nurture and support these nascent companies.

PFRAs and universities engage with existing SMEs, but generally on a small scale and only for small incremental services

PFRAs and universities provide contract R&D services to a wide range of SMEs. Approximately 70 percent of CSIRO's private sector contracts are with SMEs. CSIRO enters into approximately 2,000 contracts with SMEs per annum. Most engagements between CSIRO and SMEs, however, are $5,000-$15,000 short-term minor projects including testing services. While these services are valued by SMEs, this type of engagement is not the optimal pathway for effective technology transfer. Clearly there is an opportunity for CSIRO and other research providers to engage at a deeper level with SMEs and truly help them to continue to innovate.

Recognising the importance of working with SMEs even on small scale projects, CSIRO has recently introduced a program to reduce the transaction costs of interfacing with SMEs. SMEs had historically (and rightly) complained that interacting with CSIRO could be a painful experience – a contract averaged 22 pages long and was not standardised so would often take 70-80 days to negotiate with as much as 40 exchanges of paper between CSIRO and the SME. *FastTrack* was introduced last year and is CSIRO's new system for the execution of contracts across CSIRO which is of particular benefit to SMEs. *FastTrack* simplifies and standardises CSIRO contracts such that a contract that used to be 20 pages can now often be

executed on a single page and in plain English. *FastTrack* reduces the time involved in negotiations between CSIRO and SMEs from months to hours. Initial feedback from SME clients has been remarkably positive.

PFRAs and universities should engage more deeply and strategically on larger scale projects with SMEs

There is an opportunity in Australia for more large-scale collaborative projects between Australia's high potential SMEs and Australia's best providers of research and development. Rather than simply providing small-scale contract research services, deep collaboration is an optimal pathway from the laboratory to commercialisation. Collaboration is the "oxygen" of innovation. These projects should be driven by the needs of the SMEs – market pull as opposed to science push. These projects should be designed to accelerate the growth of the SME leading to increased exports and job creation in Australia – helping create the next generation ResMeds and Cochlears. PFRAs have valuable intellectual property and know-how that could help certain tech-based export-oriented SMEs become more successful. PFRAs and universities have a desire to work deeply with SMEs in this fashion. This may represent an important pathway through which we can take $5-10 million per annum SMEs and help them become $100 million or larger companies. Many SMEs have expressed a desire for this level of interaction as well (examples include Adacel, Allied Group, Cap-XX, CEA Systems, IDT, Integrated Research, Minesite Technologies, PiVoD, etc). CSIRO's breadth and depth of intellectual property and know-how across sectors makes CSIRO a natural starting point in helping Australian SMEs in this manner. Furthermore, CSIRO carries out longer term, higher risk industrial research, which Australian SMEs cannot perform because of their small size, offering a very complementary partner to the SMEs.

However, there is a structural gap that prevents PFRAs from engaging more deeply and strategically on larger-scale projects with SMEs

Deep collaborations between SMEs and PFRAs and universities are not occurring on a systematic basis. Some examples exist but they tend to be few and far between (see Appendix 1). Many SMEs are interested in working with PFRAs and universities to access their rich caches of IP and knowledge, but these deep collaborations do not happen for several structural reasons.

Firstly, successful SMEs cannot afford to invest (or choose not to invest) in larger scale continuing R&D. Even if they have available funds, the ongoing costs of SMEs' existing operations prohibit even high potential SMEs from investing in their own futures. Capitalising on new innovation is a significant challenge for SMEs, both financially and organisationally. Many SMEs are overwhelmed when faced with building the next generation products and services to serve evolving customer needs and keep rivals at bay, and at the same time deal with the complexities of production, marketing and existing operations.

Usually the majority of a typical SME's R&D innovation tends to occur only in the early years of its lifecycle. Once the initial products or services are developed, the enterprise then prioritises other activities, particularly sales and marketing. The situation is exacerbated by the current difficult fundraising environment that encourages SMEs to preserve capital for business operations and other incremental revenue-generating initiatives, rather than invest in riskier innovation activities. Thus, SMEs generally do not have sufficient capital and are uncomfortable bearing the financial and management risks of continuing their own innovation, let alone pursuing large scale collaborations with PFRAs and universities.

Partnering with a PFRA or university may help enhance the SME's innovation and commercialisation prospects, but the opportunity costs are often too high. Such large-scale collaborative projects are beyond the financial capacity of SMEs to fund out of their cash reserves, and are not the types of investment that private equity or venture capital firms typically make. Venture capital funds and the private sector have a risk/reward profile that prevents them from investing in collaborations between SMEs and PFRAs or universities. Australian venture capital firms, in particular, take a conservative approach to funding young companies and tend to favour funding market development rather than product development activities.

Secondly, PFRAs and universities have a desire to work deeply with SMEs, but do not have the

financial flexibility to subsidise the work. PFRAs and universities are keen to work with SMEs, and possess skills and world class know-how that could help boost the opportunities for SMEs. However, PFRAs and universities have high fixed costs and a business model that requires a certain level of external earnings in order to maintain operations. PFRAs and universities would need to develop greater flexibility in order to allow subsidisation of collaborative research projects. Tight financial budgets make it nearly impossible for PFRAs to forego contract research revenue and instead share in the risk/reward with SMEs.

Within CSIRO, for example, individual Divisions do not have the financial flexibility to invest in the future potential of an SME. Reallocating internal resources is not a viable option as it would cause significant staff dislocation and negatively impact core research capabilities and would only facilitate a small number of deeper interactions with SMEs. Also, public research providers can not price at a level that undermines possible private sector research providers. Currently, CSIRO struggles to participate in deep collaborations with technology based SMEs without a mechanism to fund the work externally, although the organisation is exploring options to gain additional flexibility.

Thirdly, existing mechanisms of funding collaboration do not go far enough. Programs such as Commercial Ready help facilitate collaborations, and other such government programs are a step in the right direction, but do not entirely solve the problem. Commercial Ready does offer an incentive for SMEs to partner and continue to innovate. Because Commercial Ready requires an SME to fund 50 percent of a funded project, however, Commercial Ready does not provide strong enough incentives for SMEs to collaborate with PFRAs/universities on new large scale collaborations that will meaningfully impact the growth of the SME. Commercial Ready's 50 percent investment requirement puts a substantial up-front burden on SMEs considering this type of collaboration. CSIRO has had several constructive collaborative discussions with the Department of Industry, Tourism and Resources, working together to explore this issue. Currently, there is no effective mechanism that reduces the capital and management risks for expansion stage technology-based SMEs in working with PFRAs and that also addresses the financial exposure of PFRAs in responding to the research needs of small companies.

What is needed is a way to bridge the gap that currently prevents high-potential technology based export oriented SMEs from participating in large scale demand-driven collaborations with PFRAs and universities.

While there is no single silver bullet to resolving the challenges around fostering these types of large scale collaborations, several possible improvements might be considered.

Possible priority improvements

Reflecting on CSIRO's experiences in the innovation space, there are four possible priority initiatives and seven others worthy to bring to the committee's attention. These possible improvements could help to remove some of the barriers to collaboration and innovation that were identified above, particularly with regard to SMEs.

Possible improvement #1: Australian Growth Partnerships (AGP)

CSIRO has developed a proposal for a new government funded program that would provide funds directly to selected SMEs to engage in large scale collaborations with Australia's leading providers of R&D services. In order for this type of co-development projects to occur, a fund would be created that selects and funds high potential proposals on a competitive basis.

Funding collaborative R&D projects is not without risks. However, several mitigating factors help to make the AGP model attractive from a risk/reward perspective. Only high potential, or "star" SMEs would qualify for funding from the AGP program. Such star SMEs already have a track record of success in bringing innovation to market. Star SMEs already have experienced management teams, distribution channels, and a history of creating value for their stakeholders. These star SMEs understand the risks and opportunities of participating in large-scale collaborative R&D projects. They are poised to become global players, and simply need a way to get there more quickly, fuelled by innovation.

A clear map of the timing of expected commercialisation milestones is a prerequisite for a

project to receive funding under the AGP model. Funds would be distributed towards a project only as milestones are reached. If a project flounders, good money would not follow bad. Therefore, an unsuccessful collaboration would be cut off before money is wasted. Only high potential collaborative projects would be funded.

An independent selection panel composed of experts from R&D organisations, universities and industry would assess proposals on a risk/reward basis. Given that there would be very few proposals selected, each successful proposal must have strong potential for value creation given the risks. Successful projects would involve high potential IP and world-class expertise from Australia's best research organisations and universities. The selection process would not only judge the quality and potential of the star SME, but would also judge the quality and potential of the research partners and IP at issue. Successful proposals would match world class IP and expertise with the needs of the star SME.

Such a fund requires a commitment of at least $10-20 million per annum over a four year period. The fund would facilitate between one and five projects each year. This level of funding could enable AGP to create significant impact and become a self-sustaining program over time. The AGP model is not a grant program. Nor does it require 50-50 matching from the SME like other programs.

AGP could be a self-funding program over time. Financial models suggest that AGP could be a self-sufficient program in five to seven years. Similar to the HECS model, star SMEs that benefit from participating in the program would repay the funds back to the program. SMEs that do not benefit from the program are not required to contribute back to the program. SMEs' contribution back to the AGP program would be in the form of licence fees and/or royalties from new products or services created through the collaborative project. The likelihood of success and the potential recuperation of funds would be one of the factors used in selecting proposals for funding.

In addition to AGP's recuperation through licence fees and royalties, governments would also receive increased payroll taxes and income taxes from the successful SMEs. Some examples of working solutions with similar characteristics exist in Canada (the National Research Council's Industrial Research Assistance Program), Israel (Magnet Consortium), and in the US (Small Business Administration programs). No such program exists in Australia.

Possible improvement #2: Reducing transaction costs for interactions with SMEs

FastTrack is an online system that provides a streamlined approach for developing the more routine, low risk, small contracts that make up 80 percent of the contracts CSIRO generates. CRCs, universities and other PFRAs may be encouraged to adopt a *FastTrack* type system to reduce transaction costs of working with SMEs by simplifying and standardising the contracting process. *FastTrack* is one of CSIRO's key business improvement initiatives over the last two years, around the simplification of CSIRO's approach to legal contracts. *FastTrack* has been built in-house to facilitate the generation of legal proposals and standardise CSIRO's approach across the organisation. *FastTrack* offers a real improvement in CSIRO's ability to obtain business and provide a better service to clients. Primarily designed to deliver more customer-friendly legal terms and a more consistent approach across Divisions, *FastTrack* also helps staff by automating steps in the process, such as minimising duplicate entry of information and streamlining approval processes, freeing up more time to negotiate larger, more complex agreements. Other organisations could be encouraged to create their own versions of *FastTrack* or could leverage CSIRO's experiences in developing such a system.

While this solution would not necessarily foster more deep collaborations, it would at least help facilitate more interactions with SMEs. By reducing the friction and transaction costs, SMEs would have another incentive to work with Australian PFRAs. This improvement would also help reduce SME perceptions of PFRAs and universities as bureaucratic and unresponsive.

Possible improvement #3: Policy mandate to PFRAs and universities

Rather than creating a new program or structure, a policy mandate to universities and organisations such as CSIRO would also foster increased interactions with SMEs. Clearly, subsidised or costless services would provide a very strong

incentive for high potential SMEs to engage deeply with PFRAs and universities.

Such a mandate would direct CSIRO to prioritise work with SMEs even to the extent of subsidising such work given the strategic importance of SMEs to Australia. Each PFRA and university would be responsible for determining the most appropriate way to implement such a mandate. But clear performance targets and guidelines would provide direction.

As an example, CSIRO might be directed to pick a handful of SMEs and prioritise the needs of the SMEs through a multi-year collaborative partnership regardless of the SMEs' ability to pay. Clearly CSIRO would need to be mindful of maintaining competitive neutrality in the selection of such SMEs.

Such a mandate may or may not be accompanied by additional funding to facilitate the subsidisation. If no new funding was provided, organisations like CSIRO would be required to reprioritise existing work and forego some activities in favour of the new focus on SME collaboration. Without new funding, there may be a loss of capability or capacity within PFRAs and universities, which would be a negative repercussion. It is also unclear how significant the impact on SMEs could be without additional funding.

Possible improvement #4: Additional mechanisms to encourage researchers to develop experiences in industry and for people from industry to have experiences working within a research organisation

Interactions between people are one of the keys to successful innovation and technology transfer. Technology travels on two legs. Australia would benefit from more people on both sides of the PFRA / industry divide with serious understandings and experiences across the divide. People who have experiences both from industry and from within a research organisation can be especially effective at bridging the divide between industry and research organisations. There is also a lack of experience in Australia in taking technology-based products to global markets and in growing technology-based firms rapidly. Some would argue that the US has seen much stronger connectedness between universities and industry, in part because many people share their time between the two – academics spending their summer working for a company or other such mechanisms. Additional approaches in Australia of this kind, including joint appointments, sabbatical arrangements and domestic and international secondments could have a substantial impact on technology transfer in Australia. Increased prioritisation on developing a rich and varied set of industry experiences within Australia's research communities would facilitate even better interactions between PFRAs, universities and industry.

Additional possible improvements

While not as high priority, the following seven possible improvements are also worth the Committee's consideration.

Possible improvement #5: A new Seed Fund venture capital program for larger SMEs which collaborate with PFRAs and universities

The Commonwealth Government's Pre-Seed Fund program (PSF) targets the commercialisation of research outcomes that are generated by Australian universities and PFRAs. The PSF helps overcome the lack of funding and resources available in Australia to support very early stage opportunities. The program has been designed to provide incentives to private sector venture capital fund managers (VCs) to invest in pre-seed stage start-up companies. The VCs are able to leverage the Commonwealth investment and boost their return on investment in young start-up companies. The VCs administer the funds and utilise their pre-existing filtering mechanisms to attempt to select winning opportunities.

By only focusing on pre-seed opportunities, the PSF helps get discoveries out of the laboratory and builds new businesses around the intellectual property. The PSF program does not, however, fund market driven collaborations between established high growth SMEs and PFRAs or universities.

One improvement to the gap identified above would be the creation of a new pre-seed fund like program specifically targeted at funding SME large-scale collaborations with PFRAs and universities, especially focused on technology transfer. Like the PSF, such a program would be administered through existing or new VCs and would utilise the VC's governance and processes to ensure

success. It would provide leverage to VCs, giving them the necessary incentive to fund collaborations that otherwise lay outside their risk/reward profile. Unlike the PSF, this new program would be specifically earmarked to provide funds to SMEs which are embarking on large scale collaborative projects with R&D providers. SMEs would provide the VCs with equity in return for capital.

There would obviously be strong support for such a program from both the VCs as well as from SMEs. This improvement provides just enough of a boost to the private sector to fill the gap that currently exists.

Possible improvement #6: Adapting Commercial Ready for such collaborations

Commercial Ready is a competitive merit-based grant program sponsored by the Commonwealth supporting innovation and its commercialisation. It aims to stimulate greater innovation and productivity growth in the private sector by providing around $200 million per year in competitive grants to SMEs. Grants are available for early-stage commercialisation activities, R&D with high commercial potential, and proof-of-concept activities. Commercial Ready is a worthwhile program that makes a difference for many SMEs.

Commercial Ready encourages SMEs which are collaborating with PFRAs or universities to apply for grants, although it also encourages other types of applicants as well. One of the requirements for participants in the Commercial Ready program is for the applying SME to contribute 50 percent of the project's financial costs. This 50 percent matching requirement is an appropriate tool to ensure that there is a deep commitment by the SME. But it deters SMEs from proposing large scale collaborations with PFRAs and universities – even 50 percent of the cost is a barrier to the SME. As described above, even successful SMEs can be severely cash constrained, especially with regards to investing in ongoing innovation and commercialisation. The incentive is not enough to close the gap given the financial and management constraints of SMEs. CSIRO has had a number of constructive discussions with the Department of Industry, Tourism and Resources to explore this issue together.

One possible improvement would be to have a specially earmarked portion of Commercial Ready that was explicitly set aside for large-scale collaborations. This "carve-out" would ideally waive the 50 percent matching requirement altogether or reduce it significantly or at least facilitate the contribution of that 50 percent by a research partner such as a PFRA or a university. Such a focused and dedicated incentive for large scale collaboration is required in order for SMEs to overcome the hurdles involved in engaging with PFRAs and universities on big projects.

Possible improvement #7: Additional support for market-facing industry sectors

Australia is home to many world-class industry clusters. Market-facing clusters such as wine, defence, mining, high-value manufacturing, and environmental solutions among others, comprise large corporates as well as SMEs. Additional government support for such "solutions clusters" is one approach to fostering larger scale SME-PFRA engagement.

The Australian wine industry offers an example of how such an industry cluster can work together to commercialise innovation. "Innovation and its uptake are two key ingredients in the Australian wine industry's rapid rise from cottage industry to international success. The industry has a well-deserved reputation of leadership in the funding, coordination and adoption of both product and process innovation. This leadership continues to underpin its competitive advantage in oenological and viticultural practices, training, branding, and export" (David Aylward, "Extending The Grapevine: Innovation and knowledge transmission within the Australian wine industry", *Australasian Agribusiness Review* (2005)). The Australian wine industry is currently the 6th largest wine producer in the world and 4th largest exporter, creating around $2.3 billion worth of export sales per year with a growth rate of over 30%. The industry adds approximately 200 additional wineries each year and is considered a world leader in development, transmission and adoption of innovation (Winetitles, 2003 referenced in Aylward, 2005). The Australian wine industry is largely considered a prime example of how competitive advantage is achieved through the effective collaboration of suppliers, producers, government bodies and research organisations (Porter, 2002 referenced in Aylward, 2005).

Such clusters promote both competition and cooperation and can often band together to access R&D-based innovation on large scales. Providing further assistance to these types of market-facing clusters would be a step towards bridging the gap identified above.

Possible improvement #8: Increased awareness in the marketplace of current assistance programs

Many SMEs struggle to understand the range of options available to them. CSIRO has spoken with several SMEs that are either unaware of their options or are confused by the myriad of programs available. Additional efforts to clarify, communicate and possibly coordinate the benefits of the many programs available would help encourage SMEs to utilise the programs that are the best fit with their needs.

Possible improvement #9: A clear outcomes framework with regards to SMEs to help guide PFRAs and universities

Currently, PFRAs and universities may have self-imposed performance measures with regard to interactions with SMEs. There is currently no system-wide agreement as to measures of success of SME interactions. Developing an agreed upon set of key performance indicators and measuring the success of outcomes with SMEs against those indicators might help facilitate better linkages with SMEs.

Possible improvement #10: Additional support for intermediaries, brokers and facilitators

CSIRO applauds the efforts of AIC's TechFast, the Ai Group's InnovationXChange, the COMET business advisor network and many other intermediaries, brokers and facilitators in Australia who are helping SMEs continue to innovate and bring those innovations to market. Additional support for such intermediaries, brokers and facilitators to gain scale would benefit a large number of SMEs.

Possible improvement #11: Line funding of technology transfer offices

The importance of knowledge transfer as a "third stream" role for universities (and by extrapolation PFRAs as well) was highlighted in Richard Lambert's UK-based *Lambert Review of Business-University Collaboration* in December 2003. Today, PFRAs and universities balance competing priorities to determine how much to invest in their own technology transfer and commercialisation office. CSIRO, for example, has decided over the last few years to substantially increase its investment in business development and commercialisation infrastructure. Direct support on a line funding basis for PFRA and university technology transfer offices could be a tool to boost linkages between research organisations and industry, especially SMEs. Such funding could be tied to a clear outcome framework (see possible improvement #9 above) and could involve dollar for dollar matching by the institution.

Conclusion

CSIRO is focused on ensuring the greatest impact possible from its investment in science. Science for science's sake is insufficient. To have the greatest impact, CSIRO needs to ensure that the models and methods adopted for transferring technology to the ultimate adopter are as effective as they can possibly be. This is an area where there are no hard and fast rules. What may work for one industry sector may not work for another. What works for one type of research may not work for another. It is highly dependent on the individuals and organisations that operate within each space.

Ultimately, technology transfer is all about people engaging with other people. Working out how best to communicate requires careful thought in each circumstance. Importantly, effective technology transfer is not all about the number of patents or spin-offs created. It is also not about the amount of value that is captured along the way. It is mainly about impact – the amount of value that is ultimately generated for Australia by diffusing and transferring research and development outcomes to the right parties at the appropriate time in the most effective way.

SMEs, in particular, are important vehicles for innovation to have impact in Australia. There are currently structural barriers that impede SMEs from easily accessing the rich catchments of innovation in Australia's PFRAs and universities. By removing these barriers, Australian SMEs would have an additional opportunity to continue to stay ahead of their global competition. CSIRO is eager to help make that happen.

Appendix 1

CSIRO case study examples that highlight a variety of technology transfer pathways

The following collection of case studies highlights the range of technology transfer pathways in which CSIRO engages. These case studies demonstrate a range of different partnership approaches, business models, and outcomes. The case studies defy categorisation, but they all have one thing in common: strong interactions between dedicated people made them happen.

Intellection

Intellection is the global leader for rapid, automated, quantitative evaluation of minerals, rocks and man-made materials using QEMSCAN™. QEMSCAN™ is the fastest and most productive microbeam mineral analysis system in the world and is currently also assisting in forensics of crime scenes. The technique provides detailed information on ores and concentrates that was previously not available by any other means.

Intellection was launched by CSIRO in October 2003, after 20 years of comprehensive and rigorous scientific research and discovery, to better market, develop and support its unique mineral and material analysis technology, called QEM*SEM® (Quantitative Evaluation of Materials by Scanning Electron Microscopy).

Windlab Systems

Windlab Systems is a wind energy development partner specialising in highly accurate wind resource assessment technology for the purpose of identifying and validating commercially viable wind farm locations anywhere in the world.

Windlab Systems has carried out high resolution wind resource mapping for a number of state and federal agencies providing vital information for use in planning, management of wind farm developments and dealing with grid issues. State agencies such as the Sustainable Energy Authority of New South Wales and the Sustainable Energy Authority of Victoria are actively sharing in the benefits of fine scale wind resource information over broad areas.

Windlab was set up in 2003 and is now operating as a private company, by former CSIRO scientists who developed what is seen to be world's best available wind resource technology, WindScape and Raptor NL. Windlab is involved in the development of continental-scale wind atlases, high resolution wind maps, data acquisition and analysis, wind farm site prospecting, wind farm design and early stage wind farm development.

PolyNovo Biomaterials

PolyNovo is focused on developing a range of biocompatible and biodegradable polymers that will be used in next generation medical devices across multiple therapeutic areas. PolyNovo's solutions offer reduced invasiveness, curing from a liquid to a polymer form, mechanical strength, recruitment of cells that aid healing, and biodegradability, all in medical procedures.

Products are based on the biodegradable polymer technology platform developed by a team of scientists from CSIRO Molecular Science. CSIRO invested IP in the start-up company. In May 2004, Xceed, an Australian Stock Exchange (XBL) listed biotechnology investment company, supplied $5.1 million in exchange for 50 percent of PolyNovo equity.

Product milestones are the creation of bone cement and bone substitute, drug delivery coatings, periodontal reconstruction and glues and medical adhesives and sealants. PolyNovo's current development program is aimed at formulation optimisation and completion of functional animal trials for bioresorbable glues and cements for fixation of complex and non-union fractures and bioresorbable drug eluting coatings.

As this work progresses towards the completion of pre-clinical development, PolyNovo seeks to establish partnerships with academic, clinical and device manufacturers for rapid product development and successful market introduction.

BetaBiotics

BetaBiotics is focused on identifying and developing small organic molecules that inhibit bacterial DNA replication via new mechanisms of action with the ultimate aim of developing new classes of antibiotics that have the potential to address bacterial resistance. It is expected that

developed antibiotics will suffer less from the phenomenon of bacterial resistance that threatens patients all over the world.

The market for systemic antibiotics constitutes the third largest worldwide pharmaceutical market, generating $24.7 billion in worldwide sales in 1999, including $8.45 billion in the United States. The in-hospital antibiotic market, where bacterial resistance poses the most serious threat, totalled $7.5 billion worldwide during this period.

Betabiotics was created in September 2003 as a subsidiary of CSIRO. The Betabiotics approach has already identified more than 20 compounds that have antimicrobial activity against at least some of the commercially relevant bacterial strains (E.coli, S.aureus, K.pneumoniae, P.aeruginosa, E.faecalis) assayed so far.

With a number of new classes of lead compounds now identified and a powerful method to identify others, Betabiotics is ready to progress its drug development program in order to produce candidates with sufficient antimicrobial activity to enter animal studies. Additionally, funds are required to secure the company's growing IP position. The company is now seeking to secure additional early stage capital.

Grazfeed

GrazFeed provides graziers with a tool to assist their farm management decisions. It predicts how much, and what type of, supplementary feed is needed to reach a particular production target. Farmers can view the potential physical and financial consequences of a change in management practices, and therefore manage their business risk.

GrazFeed was initially developed by CSIRO with some funding from the Wool Research and Development Corporation. New South Wales Agriculture became involved prior to GrazFeed's first release and trained their officers, agronomists and researchers in its use and subsequently promoted GrazFeed by incorporating it into its PROGRAZE course for livestock producers. Horizon Agriculture was licensed to sell compiled versions of the program.

It has been estimated that using GrazFeed results in a 10-30% reduction in expenditure on supplementary feeding. Based on a conservative saving of 10%, the net economic benefit has been estimated at $350m for a development cost of $4.4 million.

DNA test for beef tenderness

A DNA test for genetic variation in beef tenderness has been developed by CSIRO. Tenderness is one of the most important aspects of meat quality for consumers, yet the grading of beef deals with surrogates to try to predict meat tenderness.

The technology has been licensed to Genetic Solutions – an Australian SME that is now entering international markets. More than four thousand tests have been performed for the high value breedstock industry since the launch in November 2002. In May this year, Genetic Solutions was a joint recipient of an Excellence in Innovation award from the Prime Minister.

Boost to Crop Research

CSIRO's patented RNAi technology is a breakthrough technology with potential for application across a number of fields including the development of novel traits in plants as well as animals. Using RNAi, CSIRO researchers first demonstrated 'gene-silencing' in an organism in 1995.

CSIRO has entered a licence agreement with Bayer BioScience NV covering application of RNAi gene-silencing technology in certain major crops. This is the first licensing of this technology to a leading agri-biotechnology company. RNAi can be used to introduce disease resistance, enhance nutritional qualities and control flowering by removing unwanted gene functions.

Air Cargo scanner

The Air Cargo Scanner developed by CSIRO provides rapid, high resolution, non-intrusive and material specific imaging for enhanced detection of illicit substances in consolidated air cargo. Air cargo containers can be screened airside (secure), without logistically complicated deconsolidation, in less than two minutes. Dual neutron and gamma-ray technology provides a level of material identification not available in x-rays - a key reason behind the limited use of x-rays for air cargo screening. Whilst neutron technology is not entirely

new, CSIRO has made it much cheaper, faster, more effective and easier to use than was considered possible for air cargo screening applications.

The Air Cargo Scanner was developed by CSIRO following an approach from the Australian Customs Service in 2002. Customs funded a series of studies, culminating in the development of a full-size laboratory prototype and has committed to funding the construction, trial and operation of an Air Cargo Scanner facility at Brisbane Airport, to be operational by mid-2005 and screening up to 100% of commercial air freight.

Virtual Critical Care Unit

The Virtual Critical Care Unit (ViCCU™) system consists of a trolley placed by the patient's bed which communicates with a specialist's station at the main hospital. Using next generation broadband internet technology this provides an 'always on' telepresence link so a specialist can remotely direct a medical team.

The system has been delivered to the Blue Mountains and Nepean Hospitals with high-speed connectivity provided by the NSW State Rail optical fibre network. ViCCU™ improves access to specialist advice, resulting in speedier diagnosis and immediate commencement of appropriate treatment, particularly in remote locations.

Optical components for the Jet Propulsion Laboratory

State-of-the-art optical components have been supplied to the Jet Propulsion Laboratory in the USA for a space interferometer, part of NASA's New Millennium Program, 'Space Technology 7'. The components are made to exacting specifications requiring ultimate precision and will help NASA determine the suitability of different technology platforms for the next generation of space instrumentation.

SilviScan

The first SilviScan machine designed specifically for commercial application was built at CSIRO's Clayton laboratories and delivered to our partners, the Swedish Pulp and Paper Research Institute. Fast, accurate wood testing makes it possible to map the suitability of plantation timber for particular end-uses from paper to furniture. These capabilities potentially add millions of dollars per annum to the value of Australian and international plantations.

Remote sensing technology for ash detection

A remote sensing technology for the detection of volcanic ash and sulphur dioxide, a known major aviation safety hazard has been patented by CSIRO. Under an agreement with Tenix Industries for the commercialisation of the patented technology, a ground-based infra-red detector has been trialled successfully at Mount Etna, Sicily. It has the potential to become an integral part of air transport safety systems and further reduce the risks of air travel.

Collaboration with NASA and Boeing

In collaboration with NASA and Boeing, CSIRO has developed a robust and scalable system for aerospace applications to demonstrate a new approach to solving problems. The system handles large amounts of data, avoiding network saturation and central controller failure based on CSIRO's growing expertise in understanding emergent behaviour in multi-agent systems.

The demonstrator system built for NASA can detect and evaluate high-speed particle impacts, has no central controller, handles data from many sensors, and makes intelligent decisions based on damage evaluation, diagnosis and prognosis in a distributed system.

Improving sand production prediction

The influx of large amounts of sand into oil and gas wells may result in damage to equipment, loss of productivity and can be a major safety risk. CSIRO has provided a major Australian oil and gas company with a geomechanical model, to allow a better understanding of sand production processes, operating conditions and measure for mitigating the problems and optimising production. CSIRO's work has changed the company's view on coarse-grained formations which were previously perceived to be the weakest in the field.

Commercial production of Black Tiger prawns

The Black Tiger prawn industry in Australia has been totally dependent on wild broodstock, a high risk strategy that precludes selective breeding to enhance the profitability of the industry. A nationally coordinated research effort with industry and other partners has provided quantitative information on the reproductive output of Black Tiger prawns reared in captivity. Information on the viral pathogens that occur in wild founder stocks from different regions has also been obtained. Commercial production of the progeny of captive reared broodstock has been achieved.

Pesticide residues

In conjunction with Orica Australia Pty Ltd and Horticulture Australia Ltd, CSIRO has developed an enzyme bioremediation technology for the clean-up of pesticide residues in the environment. An enzyme that degrades synthetic pyrethroids has now been transferred to Orica, which has trialled the enzymes successfully in a range of application for use by farmers, dip operators, crop dusting pilots and fruit and vegetable packers.

Integrated wood processing

The Integrated Wood Processing demonstration plant is a joint development initiative between CSIRO, Western Power, the Oil Mallee Company (a SME owned by farmers in WA) and Enecon (a Victorian SME engineering firm). The plant will generate renewable electricity and produce activated carbon and eucalyptus oil from locally planted mallees. The plant will generate enough renewable energy for 1,000 homes and help address global warming and farmland salinity issues. The plant uses modern fluidised bed technology developed by CSIRO to convert the wood into charcoal and then to convert it to activated carbon.

Gravity thickener

Gravity thickeners are crucial pieces of equipment for processing minerals whenever the process involves wetting the ore. They are used to separate fine particles from the fluids holding them in suspension to produce a thick mineral rich slurry (underflow) and clear liquid stream (overflow).

Although thickeners are often considered to be mature technology, they are notoriously erratic and inefficient in operation.

A multidisciplinary team of chemists, engineers and fluid dynamicists conducted a range of research from fundamental scientific investigation to on-site investigation. The project developed a comprehensive understanding of thickener operation and created models that have been used to optimise the performance of a wide range of thickeners.

The project has been supported by 27 companies through the industry association AMIRA International. Already, from an investment of $10 million ($7 million from industry) the project has delivered an estimated $295 million in benefits to the industry, with another $250 million projected. Additionally, the companies have identified further specific issues for further research and ultimate implementation in the fifth extension of the project.

High Power Supercapacitors for wireless communication products

Australia has become a world leader in supercapacitor technology through a CSIRO initiated research program that began in early 1992.

CAP-XX Pty Ltd ("CAP-XX") is an Australian company that was incorporated in 1997, and focuses on developing and commercialising advanced supercapacitors – high power energy storage devices. Supercapacitors can be used in a variety of industries as diverse as telecommunications, computer, power quality and automotive applications. These high-power energy storage devices enable manufacturers to make smaller, thinner and longer-running products such as cell phones, PDAs, medical devices, AMRs and power tools. With their high power and energy densities, supercapacitors are capable of producing the high burst power required, for example, when taking a digital photo, sending wireless phone or PDA transmissions, providing back-up energy or hot-swapping battery packs. In the short-term CAP-XX is targeting wireless communication and notebook computer applications.

The technology underlying the supercapacitors was initially developed in a joint project conducted by Plessey Components Pty Ltd and the CSIRO that commenced in 1994. The research and

development work with CSIRO was accelerated after CAP-XX was registered as a company. CAP-XX has received both New South Wales and Commonwealth government funding (including two AusIndustry R&D Start Grants) to help commercialise the technology. CAP-XX's work has recently been recognised by the World Economic Forum having been selected as one of their Technology Pioneers for 2005.

CAP-XX customers include manufactures of GPRS/EDGE/3G communication devices such as smartphones, PDAs, PCMCIA and Compact Flash modems plus enabling emerging medical and consumer applications such as White LED flash in cell phones and digital cameras. CAP-XX products have received Green Partner Certification from Sony Corporation, a necessary step for all companies supplying components to Sony.

The private company has its main operational base in Sydney, Australia, and sales offices in South Carolina and Texas, USA and Taipei, Taiwan. 2005 will see a significantly expanded production with Polar Twin Advance (PTA) of Penang, Malaysia joining as a strategic manufacturing partner. Other partnerships include US giant Intel, global finance corporation ABN AMRO, Taiwan-based global PC manufacturer Acer, Technology Venture Partners, Innovation Capital and large Silicon Valley VC fund Walden International.

The total available market for high power small form factor supercapacitors has been estimated to be currently greater than US$ 100 million and is expected to be greater than $US 1 billion by 2010.

Multidisciplinary CSIRO skills and resources have been employed to give CAP-XX a competitive edge in the global marketplace. The ultra-high performance of the existing CAP-XX supercapacitors has been enabled through over a decade of leading-edge research and development that has resulted in a product that gains a clear competitive advantage through the tailored use of nano-structured materials and nano-scale processes.