CSIRO STAFF ASSOCIATION

CSIRO's staff – CSIRO's future

Submission to the Productivity Commission Inquiry

Economic, Social and Environmental Returns on Public Support for Science and Innovation in Australia

August 2006

Contents

Acronyms

AIMS	Australian Institute of Marine Science
ANAO	Australian National Audit Office
ANSTO	Australian Nuclear Science and Technology Organisation
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEST	Department of Education, Science and Training
DSTO	Defence Science and Technology Organisation
GDP	Gross Domestic Product
OECD	Organisation for Economic Cooperation and Development
PMSEIC	Prime Minister's Science and Engineering Innovation Council
R&D	Research and Development
SET	Science, Engineering and Technology
SME	Small and Medium sized Enterprises
US	United States of America

Introduction

The CSIRO Staff Association thanks the Productivity Commission for the opportunity to provide comment to the inquiry into the economic, social and environmental returns on public support for science and innovation in Australia.

The CSIRO Staff Association is a section of the Community and Public Sector Union (CPSU) and represents over 3000 staff of the CSIRO and the Anglo-Australian Observatory. The CPSU represents members in AIMS, ANSTO, DSTO, the Antarctic Division, the Bureau of Meteorology, Geoscience Australia and scientific groups in agencies and centres across the Commonwealth public sector. The CSIRO Staff Association is therefore well informed of science and innovation issues throughout the public sector. This submission, however, concentrates on the experience of CSIRO as a leading government agency in the conduct of scientific research and development in the Australian innovation system. In particular we focus on impacts of CSIRO staffing which influence research outcomes.

The role of CSIRO in the national innovation system has always encompassed science, government, industry and the Australian community. Over time CSIRO has developed into a national icon renowned for its scientific excellence and impact on Australia, economically, socially and environmentally. In broad terms, current expectations of CSIRO's role as determined by management are:

1. the performance of public good research – i.e. in agreed high priority research areas;
2. the delivery of scientific research for the development of new and existing Australian industries;
3. acting as an honest and forthright conduit in debates and disputes with government, industry and the community;
4. forging linkages with international research partners;
5. promoting scientific and technological awareness in the community; and
6. demonstrating the value of science in Australian society.

The Science and Industry Research Act 1949 requires CSIRO to carry out scientific research to assist Australian industry, further the interests of the Australian community and to contribute to the achievement of national objectives. CSIRO must also facilitate the application of the results of research, both its own and others; provide scientific services and facilities; liaise with other countries; train research workers; provide fellowships and grants; and publish and disseminate information.

It is not our intention to provide comprehensive evidence to demonstrate CSIRO's impact for Australia and value for the public dollars spent on CSIRO. Outcome based accountability of research funding is widely practised by staff within CSIRO. We anticipate that these details will be presented by CSIRO as well as other submissions to the inquiry. Rather, this submission primarily seeks to address the terms of reference regarding the impediments to effective functioning of the Australian innovation system and scope for improvements. Our objective is to provide a perspective of CSIRO staff, who are major stakeholders of CSIRO and who are committed to performing innovative research to benefit the nation.

The CSIRO Staff Association seeks to emphasise the following major issues as part of its submission:

1. public funding for R&D does indeed deliver benefit to Australia's productivity performance;
2. the potential economic impacts of public R&D funding are broad and multi-factorial and their assessment should not be limited to standard economic productivity measures alone;
3. the value of using appropriate benchmarks and performance measures is recognised, but should not be over-emphasised as they may generate undesirable outcomes in funding and research;
4. a major impediment to innovation in Australia is insufficient long-term and diverse public sector research capabilities, which has negative impacts on innovation driven by public sector R&D;
5. insufficient research capability is a result of insufficient resourcing and diversion of existing resources into unproductive bureaucracy and administration;
6. insufficient research capability restricts the capacity of public R&D to underpin and maximise the effectiveness of private sector investment;
7. decision-making principles and programme design elements are too focussed on project-based outcomes and should be reconfigured towards sector-wide and agency research capabilities; and

8. the potential social and environmental impacts of public R&D funding are undervalued by current outcome-based funding models and new approaches should be taken that recognise long-term preparedness, risk mitigation and public satisfaction.
9. The expectations of Government research laboratories must reflect the reality of significant declines in overall funding over several decades (from 0.32% to 0.14% of GDP in 2002).

By addressing these issues the productivity and value of CSIRO can be enhanced in the innovation system for Australia.

Economic Impact and Productivity

The relationship between public sector R&D investment and productivity has been the subject of numerous investigations and reports, both within Australia and internationally. A report[1] prepared for DEST in 2003 summarised the relevant evidence and found that:

1. business R&D is complementary to public sector civilian R&D – raising investment in one sector stimulates the productivity of the other;
2. private returns on investment were usually in the range of 20% to 40% and even higher (up to 100%) across the OECD; and
3. a country's ability to absorb foreign technology is enhanced by investment in own R&D and in education.

In summary, it stated that 'in order to benefit from the global public good of world knowledge, countries need to have well trained scientists, a technologically capable workforce and active engagement in cutting edge research'.

Other studies, such as The Allen Consulting Group report[2] into CRCs, revealed that 'for every $1 spent by the Commonwealth Government on the CRC Programme, GDP is cumulatively $0.60 higher than it would have been had that $1 instead been allocated to general Government expenditure'. This report states explicitly that its estimate of economic returns should be taken as a minimum, an interpretation that we support. Importantly, this economic impact does not even consider the additional benefits of public R&D due to social and environmental improvements.

An example of a research effort that has had significant economic returns with time is case study 1 (The PLASCON project). This project also illustrates notable environmental and social outcomes of a public sector research project conducted in collaboration with the private sector.

Accepted current measures of innovation include patents and commercialisation of R&D. On these measures CSIRO leads Australia in innovation. In June 2005, CSIRO held over 3900 granted or pending patents and reported that over 90 spin-off companies were based on CSIRO-generated intellectual property and expertise.

However, Australian business expenditure on R&D has been considered low as compared with other OECD countries – Australia's peers on the international scene. When comparing business expenditure on R&D internationally, a recent Australian Treasury report[3] suggested there that was not a strong relationship between the level of R&D and other measures of innovation. It also proposed that R&D incentives (e.g. tax concessions) were not the main driver of business R&D intensity.

That is not surprising. As detailed in the Productivity Commission Staff Working Paper 'Econometric Modelling of R&D and Australia's Productivity'[4], Australia's industrial structure is dominated by small to medium sized enterprises (SMEs) and a variety of other inputs contribute to determine the extent of innovation. These include important factors such as workplace skills and organisation and technological opportunity and infrastructure.

The Working Paper also elaborated the concept that it is also the productivity of R&D, not just the amount of R&D, that determines innovation and economic impact. We would argue that the productivity of R&D is contingent on having an underlying capability, which is broad and sustained long-term, to ensure and maximise the impact of new R&D investment.

A pertinent example in this regard is the current international debate on energy, particularly the energy supply profile in the future. A recent article in New Scientist[5] contained commentary from the head of the US Nuclear Regulatory Commission, Peter Lyons. Mr Lyons remarked that there were few science and engineering graduates coming through to replace reactor workers who are retiring in the US and stated that in the next decade, there will be insufficient people to build and operate new reactors.

In simple terms, it demonstrates that a lack of sustained R&D investment, in the above case in education and training, has resulted in a dramatic shift in the future viability of nuclear power as an energy supply option. Importantly, this has occurred in the USA, where the nuclear industry is far more developed in terms of research and infrastructure than a country like Australia.

In Australia, expertise in nuclear science and engineering has become very much limited to ANSTO and the regulatory body ARPANSA, as universities have reduced or even closed their Physics Departments. CSIRO made the last of its nuclear researchers redundant back in the early 1990s.

A broader assessment for Australia is contained in the recent skills audit conducted by DEST[6]. This alerts Australia to many looming shortages in science and engineering capability. At the aggregated national level the real implications of capability and the link to productivity cannot be gauged for it is the capability employed and harnessed to productive ends that matters. If less scientific and engineering capability is mobilised in CSIRO or other mission directed research, the impact is less productivity.

We believe CSIRO has traditionally been positioned to alleviate these R&D bottlenecks due to its broad scope and its close link with industry. However, improved public investment is needed to prevent CSIRO from having to ‘pick winners’ (e.g. clean coal research over renewable technologies) within its research portfolio.

The long-term impact of public investment into R&D sustains a capability or a preparedness, which can not simply be evaluated by recent productivity measures. The net productivity outcome is multi-factorial, but directly dependent on having a critical mass of underlying long-term public R&D.

Benchmarking and Performance Management

The need to benchmark to ensure scientific excellence, accountability and impact of public R&D investment is widely practised in CSIRO. There have been a variety of mechanisms introduced in recent times to address these issues, such as the Research Quality Framework and the Science Assessment Reviews within CSIRO. The CSIRO Staff Association supports benchmarking that is efficient, transparent and relevant to researchers. However, we do not support benchmarking or performance management structures that introduce bureaucracy and restrict diversity and creativity or operate on inappropriate time scales.

We believe that national public perceptions of Australia's publicly funded science should be benchmarked and assessed against the benchmark on a regular basis. International perceptions of Australian science may also provide a relevant measure of the value of the public investment in R&D to the nation. Both these factors influence the capacity to recruit and retain capability in the Australian SET workforce - a highly valued sector facilitates the renewal of productive capacity as technology and industry change.

The recommendations from the PMSEIC report on The Role of Creativity in the Innovation Economy[7] explicitly recognised the value of creativity in the innovative process. Recommendation 1 stated:

To realise the competitive potential of the Australian nation by adopting new innovation policies that recognise the central role of creativity and the creative industries within a rapidly changing environment.

Scientific creativity can be hindered within CSIRO and other public research institutions in a number of ways:

1. an excessive workload on the scientists which limits their scope to pick up on opportunities and evolving research areas;
2. competing demands of government and clients which can restrict the capacity to concentrate on a given scientific problem/issue;
3. excessive competition for funding, both within an institution or agency and externally;
4. lack of job security, reflected in scientific redundancies and increased use of fixed term contracts for employment;

5. loss of senior researchers and experienced technical staff, which limits knowledge transfer and the mentoring of the next generation of innovators;
6. insufficient access to, and communication with, the scientific community and professional societies;
7. lack of planned training for development of staff, including research management;
8. poor international reputation and recognition of Australian science;
9. lack of infrastructure provision and progressive specialist support, including libraries and information technology; and
10. inadequate opportunity for researchers to influence organisational strategic direction and priority setting with too-rapid rates of change in priorities.

Lack of creativity restricts national productivity by constraining the options available to deal with issues of public policy or private development. It restricts the role that scientists can play in communicating science to society. Following recent criticism and damaging publicity[8], CSIRO updated its public communication policy to endorse scientists as frontline communicators. But without more funding to ease the workload on the research effort limitations exist for creating more value with increased communication. The international branding of Australian science is precious and the ability to recruit and retain staff in a global market is important for R&D productivity.

R&D insight and creativity also generate many options to deal with issues. Policy or development generally chooses one or few options (e.g. for energy supply, water allocation, pollution management), and the 'failure' of many options to be taken up is expected and normal. A more crucial failure would be organising a system that fails to create a broad enough range of options for complex issues. For example, resources in CSIRO must permit a balance of different options for managing CO_2 emissions, considering geosequestration, alternative fuels, renewable energy options, transportation-system changes, and others, without a 'winner' too early in the debate. An example of publicly funded R&D providing options for policy is in case study 2 (Sustainable water usage).

We believe CSIRO may have gone too far in introducing project management bureaucracies following the findings of the Auditor General's Report (No 51, 2002). This has resulted in increased reporting requirements on researchers in both appropriation and externally-funded projects. Staff have been increasingly treated as employees of the project they work in, rather than employees of the organisation, such that their employment is often tied to the life of a project as opposed to CSIRO's need to retain their capabilities. There is little analysis to suggest greater productivity and efficiency with the recent adoption of project management bureaucracy, and even less clarity that the organisation is more accountable because of it. More accountability is not always better accountability.

Bureaucratic and administrative costs are an issue across the science sector, perhaps reflecting the small absolute scale of investments in world terms. Recent DEST figures[9] show increases of administrative costs (to 46.5%) in the entire sector relative to labour investments (45.3%) and capital investments (5.4%). While this reflects changing business practices, in the context of CSIRO with essentially flat budgets, this means less scientific capability for the organisations research agendas.

Training is also crucial for ongoing creativity – at present it is inadequately resourced. Through the instrument of collective union enterprise agreement making, the Staff Association has recently negotiated new training and development requirements for post-doctoral fellows in CSIRO. This crucial cohort represents the creative skills to deal with new challenges. This issue is of growing significance internationally, with recent moves on the US to improve mentoring and post doctoral development[10]. The CSIRO Staff Association believes that the post-doctoral experience in CSIRO can extend existing capability and develop new capability - the value should never be labour-cost minimisation if genuine and productive innovation is sought through R&D.

Our suggestions for improvement in creative capability within CSIRO include:

1. new mechanisms to ensure that failure is not penalised in the legitimate pursuit of creativity and innovation;
2. enhanced organisational and government acceptance of the importance of high-risk research for the 'public good';
3. greater emphasis on long-term projects and funding with decreased reliance on competitive short-term funding sources;
4. greater emphasis for training, retraining and development of staff with the production of a creative skilled workforce a recognised outcome;

5. recognition of the value of creativity within an organisation, as reflected in standards for merit promotion, classification, awards etc.;
6. encouragement of greater interaction between researchers and the scientific community and professional societies;
7. funding greater direct interaction between researchers and society;
8. reduction of bureaucracy within the organisation and with government, particularly in accountability and reporting procedures;
9. research management development to achieve effective matrix balancing of accountability and impact with capability development across scientific disciplines;
10. greater influence of researchers on organisational strategy and priority setting; and
11. matching capability development, staff training and development with shifting priorities on appropriately manageable time scales.

We believe the current requirements on CSIRO, in terms of reporting to government, particularly through its Science Assessment Reviews, are sufficiently rigorous in terms of benchmarking R&D performance. However, we believe improvements (as above) can be made within CSIRO and across the sector, in order to better guide funding decisions and enhance public and private R&D outcomes.

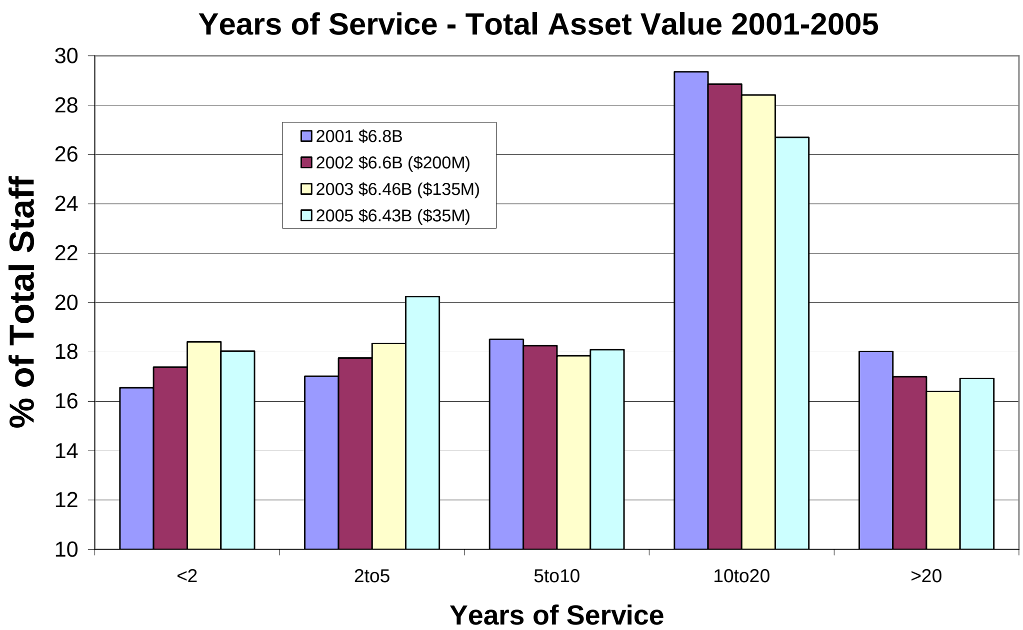
Research Capability

The term ‘capability’ is frequently used in scientific circles. In terms of CSIRO, capability not only refers to the capacity to perform and deliver on particular research outcomes, but also the ability to respond to rapidly emerging challenges, as reflected in the breadth or diversity of its research portfolio.

Capability refers to infrastructure and equipment, and more crucially to people, their skills, training, networks and commitment to science. It also reflects the support available to scientists to undertake their work, which has been maintained in mission-directed Government and business research laboratories at the expense of breadth of research (DEST Snapshot table 4.1.19) [9].

Notably, CSIRO's traditional strength has been its capacity to conduct multi-disciplinary research and thereby deliver on public benefit scientific outcomes in the long-term. This strength is enabled by attracting and retaining quality staff within the organisation and allowing the development of teams and support for researchers.

If R&D capability is valued as an asset, and the funding of capability is treated as an investment, then the CSIRO profile can be represented below,



where the net value reflects current profile of years of service and current investment in staff as salary. Longer term staff with broader knowledge, networks and experience represent a long-term investment not necessarily reflected in the annual cost. These figures show a net decline in the asset, reflecting the loss of capability. This is not easily recovered with short term hires and lack of development opportunities.

The case study on hydraulic fracturing (case study 3) illustrates the extended time-frame it takes to build up a research team to deliver demonstrable benefit in outputs. A research team in CSIRO that may have taken ten years to reach full productivity can be shut down in a matter of weeks. The case study on gas to liquids (case study 4) indicates the difficulty of re-establishing an expertise that has been lost. Short-term decision-making is a serious danger to R&D capability, productivity and innovation.

Coupled with inadequate increases in government funding to cover research expenses, it is not surprising that the lack of job security is the predominant issue currently facing most CSIRO staff. In 2005, more than 80% of all appointments to CSIRO were either fixed term or casual. A short three year contract to a new project requires training and development for the first year, delivery and productivity for the second year and career change plans for the third year. Many contracts in CSIRO are for shorter periods than three years.

Non-renewal or possible non-renewal of specified term contracts can have damaging social and human costs on a researcher. Our research indicates that it contributes significantly to disillusionment and lower morale towards the end of a contract, reducing the productivity of the individual at a time when it needs to be high to ensure delivery of outputs. This instability carries through to family and community where contributions to clubs, councils and other community interests are difficult if not out of the question for fixed term staff. In many cases the contingent employment is a reason for skilled scientific staff moving out of careers in science.

At June 2006, 27.2% of CSIRO’s total staff was employed on specified term contracts that vary in duration from 5 years down to as short as one month. The proportion of staff on such contingent employment has grown from 12% in 1992, at the same time as CSIRO staff numbers (total head count) has decreased from 7316 (June 1992) down to 6558 (June 2006). CSIRO’s annual turnover has been running at over 20% for quite a few years now.

Recruitment costs and specialised training are major burdens. Additional costs are borne by senior science managers in ‘managing’ career churn. The ANAO has reported that the average cost of recruitment of each new staff member to the Australian Public Service (APS) is in the order of one year's salary. While CSIRO will not reveal to us the cost of staff recruitment, we understand that it is considerable and in excess of the APS average.

A recent address[11] by the Minister for Education, Science and Training highlighted the issue of career progression within CSIRO and announced the following:

Imagine if our post-docs went on to long term contractual positions within our premier scientific organisations, with the possibility of international placements at similar overseas institutions. In my 'perfect' science world, CSIRO, for example, would have a certain number of competitive places available to outstanding university students seeking to have a permanent research career. The student could undertake a PhD with close supervision by CSIRO, then be offered a Post-Doctoral position, to be followed by a permanent position with opportunities for international exchanges. I have asked CSIRO to look into such a 'career ladder' scheme and what it would take to establish it.

And why couldn't such a career ladder scheme be introduced into some of our other research agencies such as ANSTO (our Nuclear Science and Technology Organisation) or private research institutions. And this raises the question, why do we equate career progression with management? Why are we surprised that Bill Gates has determined to keep his best researchers and programmers in research and programming and pay them well to avoid them leaving to pursue management roles for career advancement?

Minister Bishop also undertook to provide $18.3m for the career development of CSIRO Post-doctoral Fellows. Other than this recent announcement, the Federal Government and CSIRO have had very few effective processes in place to arrest worrying trends in the attraction and retention of quality staff within CSIRO and within the R&D industry as a whole. As a consequence, in recent times, CSIRO's discipline capability has become less diverse, diminishing its capacity to respond to emerging R&D scenarios in the future. It has acknowledged shortages in critical skills areas and has been publicly criticised for loss of expertise. Also included in these changes have been large increases in capabilities in business development, legal services and other bureaucratic, administrative and support functions, allowing clearer accountability and modern business practice. However, without anticipated growth funding these changes represent net capability loss while maintaining output. The obvious capability tensions have been transferred to short term appointments in science, reduced direct communication from scientists, less international profile and unsustainable work-life practices.

Overall, within the SET sector in Australia, there were a number of critical findings released in the latest DEST audit[6]:

1. a recognition that the level and extent of education in a population was a main indicator of innovation, as it provides the basis for an innovative and globally competitive workforce;
2. a lack of community awareness of SET, which includes a poor understanding of the beneficial role that SET plays in society; and
3. a limited knowledge of SET career options which is inhibiting the uptake of SET study.

In terms of recruitment and the labour market, the audit found that:

1. 43.8% of employees were sourced from other employers i.e. ‘poaching’;
2. only 22% of employers upgraded the skills of existing employees to meet their needs; and
3. the loss of supply of workers to unrelated occupations for science and engineering professionals illustrates the need for employers to implement effective policies to attract and retain staff, possibly through better conditions and pay rates.

Whilst we have not conducted a full analysis of the employment situation of former CSIRO employees, our members consistently report difficulties in finding a range of opportunities outside CSIRO. Many look overseas rather than accept a career-limiting position in Australia and others simply fail to obtain another position in SET. This is more of a problem for women than for men with SET skills.

Women make up a slowly increasing proportion of the staff at CSIRO (36.5% in 2002 to 38.2% in 2005), but also constitute a disproportionately higher proportion of the fixed term or casual staff than men at CSIRO. At June 2006, women constituted 35.3% of indefinite (ongoing) staff, 42.4% of fixed term staff and 55.2% of casual employees. From unpublished data provided by CSIRO, it is evident that women employees are leaving the organisation at disproportionately higher rates than men. The implementation of strategies and policies to promote diversity in the SET workforce, including within CSIRO, are fundamental to fulfilling career development opportunities for all SET professionals.

CSIRO must rebuild its scientific capability through enhanced government funding, improved decision making and transformed workplace practices. It must advocate within government and society in this regard. An elevated organisational capability must underpin the drive for ongoing scientific impact for Australia.

Labour market competitiveness is only one variable that interplays with capability. Other related factors include education and training and skills development, as well as research infrastructure and national and international linkages. Limiting any of these factors ultimately results in a reduction in the potential for creativity within the national innovation system.
It is important to note that this creative potential can not be as easily promulgated within the private sector, given Australia's industrial structure. This was, in part, recognised in the Mapping Australian Science and Innovation main report[12]:

'public sector organisations with the scale to conduct high-risk/high-return research complement Australia's business structure and help to spread the risks associated with R&D'.

In conclusion, we believe that the current major impediment to innovation in Australia is insufficient long-term public sector research capability, which limits creativity and labour market competitiveness. We have suggested general strategies and principles to address this throughout this submission.

Public and Private R&D Investment

As stated previously, there is evidence that public sector R&D investment stimulates the productivity of private sector R&D[1]. In 2005-06 alone, CSIRO generated $272.1m in co-investment, consulting and external services. Coupled with this is an acknowledgement that public sector organisations with broad research capabilities complement Australia's business structure[12].

CSIRO has always had a mandate under its *Act* to assist Australian industry. It does this by developing leading edge technologies, facilitating effective knowledge transfer and conducting R&D that industry would not normally invest in. Therefore, it is essential that CSIRO continues to perform research that will advance Australia's business development and economic prosperity.

CSIRO's proportion of external earnings has ranged between 30 and 33% of its total revenue, each year for the past ten years. This is despite the implementation of numerous strategies and policies designed to boost external earnings, both by government and within CSIRO itself. The most notable of these was the external earnings target policy. The findings of the review[9] into the policy in 2002 are still pertinent when considering CSIRO's role with industry:

'However, there are strong grounds for concluding that external earnings targets have skewed the national research effort: encouraging short-termism at the expense of longer term planning, focussing effort to areas more likely to provide a financial return; limiting collaborations with SMEs; restricting optimal performance in CRCs; and creating difficulties for the continuing build-up in value of intellectual property. There is further concern that fee-for-service activity, the 'bread and butter' form of external earnings, may be undertaken at the expense more desirable partnerships with industry that are focused to the development of innovations and (where appropriate) their commercialisation. The policy is therefore emphasising the benefit to the provider, in competition with considerations of benefit to the nation… The government and the community are primarily interested in the quality of outputs and the research impacts of CSIRO, ANSTO and AIMS.'

In 2002, CSIRO interacted with more than 3500 clients annually, two-thirds being in the private sector, with 67% of clients contributing to projects of less than $10000. Whilst this reinforces the nature of CSIRO's interface within Australia's industrial structure, more can be done to promote the effectiveness of this interaction with industry. The R&D can be very effective in driving innovative returns to such a business structure but not without the backup of public funds to maintain the capability – personnel and infrastructure (see case study 5: Steel and alumina manufacturing research).

We endorse the recommendations of CSIRO's submission to the inquiry into pathways to technological innovation of the House of Representatives Standing Committee on Science and Innovation[14]. The development of Australian Growth Partnerships, additional resources for interactions with SMEs, contract simplification and people development are all suggested improvements on existing arrangements.

However, in addition, we would advocate for better industry policies linked to scientific priorities and capabilities. The Action Agendas and collaboration funds are a start, but enhanced integration of industry drivers with scientific input is required, particularly at a government level. Currently in its absence, CSIRO's engagement with industry is often too reliant on generating partnerships at the researcher level. 80% of income generating projects are initiated and largely managed at the researcher level. Larger project funding at a broader mission level, with appropriate research management leadership, is potentially a more efficient and productive system, if the scale of funding matches the organisation's missions. This is the funding dilemma of Australian industry portfolio, with a high proportion of SMEs capable of only modest R&D investments. In the long-term, there must also be an enhanced appreciation of the value of incremental R&D development to Australian industries (see case study 6: Sheep and wool production) and a greater understanding by policy makers of the alternative pathways to innovation.

Programme Funding and Management

The Federal Government funds CSIRO via its triennial funding agreement as well as through Backing Australia's Ability for programmes such as the Flagships and the Flagships Collaboration Fund. Across the sector, a multitude of competitive mechanisms, traditionally peer-reviewed, operate to distribute public research funds, often with assessments performed at a project level.

The CSIRO Staff Association believes that decision-making principles and programme design elements with public R&D are sometimes too focussed on project-based outcomes at too small a scale, rather than valuing organisational capabilities with a more complex array of potential impacts. In this regard, see case study 7: Sustainable farming in practice. With the CSIRO Flagships programme, for example, taking a portfolio-level approach to funding and management has enabled CSIRO to build invaluable capability in critical research areas, including those addressing national research priorities. The next important challenge is to sustain this capability long-term and to continue to strive to maximise linkages with industry, the community and international partners.

To this end, the programme design elements and decision-making principles of the Flagships should incorporate portfolio-level risk management assessments, particularly for environmental research. That is, assessing the risks (economic, social and environmental) if critical research issues are not addressed by improved public R&D investment. In this way, risk assessment should be incorporated into projecting the return on investment on public R&D funding for the Flagships programme.

The CSIRO Staff Association also believes that research management capabilities in Australia are limited and require resourced training and development to ensure good outcomes when priority changes influence scientific directions. Fewer and better trained research managers facilitating consultative priority setting and efficient planning are required, with retraining and career development within science for a broad range of skills and disciplines.

Whilst supporting the Flagships concept and its effect on key research capabilities, we would emphasise that CSIRO’s research portfolio should remain broad enough to respond to emerging and unforseen challenges. It is acknowledged that CSIRO can not effectively compete internationally in all areas of R&D. However, in areas where it cannot compete, it must retain a critical knowledge transfer role in adopting new ideas and frontier technologies to the Australian circumstance.

Many of the change processes undertaken in CSIRO's science planning to adjust its research portfolio are too rapid and poorly communicated resulting in large scale loss of capability, loss of opportunities and contribute to both poor morale and poor external perceptions of CSIRO and Australian science.

CSIRO research is increasingly organised and directed. This provides better options and solutions for key national priorities, many of which contribute to national productivity. However, the current capability to do this is provided by researchers who are also responsible for 80% of external funding which maintains more than 30% of overall capability in CSIRO. These same researchers are now expected to be the frontline communicators of science to society and to maintain broad collaborative links within Australia and internationally. With the increased bureaucracy and administration of science to increasingly demonstrate accountability, it is clear that ongoing capability for renewal and to develop new priorities to address national challenges cannot be guaranteed in the current system. It is a system that assumes an infinite pool of skills and capability with no responsibility for broad training and development.

Social and Environmental Impacts

Evaluating the social and environmental impacts of public support for science is difficult, particularly with an organisation of the scale and diversity of CSIRO. However, social and environmental challenges form a significant proportion of the R&D expenditure of the commonwealth government. Recent ABS data revealed that only 54% of commonwealth expenditure has ‘economic development’ as its primary aim.

There are numerous past and present research programmes in CSIRO that have delivered impact in these areas. Whether it is challenges like climate change, water or biosecurity, or projects that address Australian problems such as bushfires and weed management, CSIRO scientists have always been at the forefront of addressing social and environmental issues for the nation.

We are not in a position to provide detailed input into the formulation of methodologies to evaluate this impact. But we would like to emphasise that much of the research that has had significant environmental outcomes has not necessarily been set up or initially directed to the results it has delivered. We understand CSIRO is proposing an overarching framework in this regard and we are encouraged by recent approaches such as the CSIRO Science Assessment Reviews, which have taken a broader, and more long-term, perspective of the benefits of research.

One pertinent and high profile example has been the global and national impact of the research into greenhouse and ozone-depleting gasses in the atmosphere, lead by Dr Paul Fraser at CSIRO Marine and Atmospheric Research. The records that this group has generated of greenhouse gas data from the air at Cape Grimm are now the benchmark for climate change models used by the Intergovernmental Panel on Climate Change. This research is leading the changing attitudes around the world to global warming. In the April - June 2006 quarter in the Australian print media alone, the Cape Grimm research featured in 50 news articles. A major feature of this research effort lies with the long term nature of the data collection - the impact of the research is of long-lasting, immeasurable consequence for the global triple bottom line.

We believe there is still a tendency in the sector to undervalue the potential social and environmental impacts of public R&D funding, particularly with rigid outcome-based funding models. This may also be a consequence of a lack of reliable indicators when compared to research with measurable economic impacts. New approaches need to be investigated that generate indicators and perspectives that value long-term preparedness, risk mitigation and public satisfaction.

For example, evaluating how much a rainforest's biodiversity is worth: conventional methodologies may give you an accurate scientific snapshot, but asking the local people, as is being done by the Centre for International Forestry Research in Borneo[15] will give an enhanced appreciation of certain kinds of biodiversity research.

In this way, CSIRO's research with social and environmental impacts should more clearly be valued by public 'end-users' who do not necessarily derive an economic benefit from the research. The value of government investment into other iconic national institutions, such as the AIS, places far more relevance on the perception of public satisfaction. We believe a similar rationale should apply when evaluating funding to CSIRO.

In summary, we submit that CSIRO is unique within the national innovation system in being able to build long-term capabilities in multi-disciplinary teams to address social and environmental problems. Changes to evaluation approaches that recognise the value of social and environmental impacts are required and will deliver far-reaching benefits to the wellbeing of the nation.

Conclusion

Internationally, Australia is at a crossroads position in terms of its science and innovation future. This was eloquently summarised by Gans and Hayes in their 2005 Innovation Update report[16]:

‘In a global economy, innovation-based competitiveness provides a more stable foundation for productivity growth than the traditional emphasis on low-cost production. Having secured a position as a leading user of global technology and creating an environment of political stability and regional leadership, Australia has an historic opportunity to pursue policies and investments to establish itself as a leading innovator nation.’

However, policies and investments should not be designed to reinforce an ordered view of innovation or to only support research with prescribed paths based on defined outcomes. Innovation is not always an exact science: discoveries such as photography and microwaves have been unveiled by accidental consequences of experimentation. Tolerating failure and unpredictability, although largely foreign within a business culture, are fundamental underpinnings in creating an environment for innovation.

Throughout this submission, we have argued that in order to sustain an innovative environment as well as generate innovation-based competitiveness, an underlying capability of public support for R&D is required. Public R&D has economic, social and environmental impacts, it stimulates private sector R&D, facilitates knowledge transfer and advances the frontiers of science.

We acknowledge that, between 1992 and 2002 for example, public expenditure on R&D in Australia grew by 3.3% per annum on average. However, we still maintain that it is essential that the nation boosts its public R&D effort in an increasingly uncertain and competitive global economy.

In recent decades, CSIRO has gradually had it funding and relative size within the national innovation system reduced, in terms of its proportion of Commonwealth government expenditure on R&D. CSIRO would require an additional annual investment of at least one hundred million dollars to simply reinstate its funding to levels of less than a decade ago.

There is now considerable evidence, including from CSIRO itself, to demonstrate that this investment would deliver extensive benefits to the nation in the long-term and facilitate the positioning of Australia as a leading innovator and beacon of scientific endeavour.

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Case Studies

Case study 1: The PLASCON project

PLASCON is a process for the destruction of hazardous chemicals and wastes in liquid and gaseous form. It was developed in the CSIRO divisions of Manufacturing Technology, Applied Physics, Chemical & Polymers and Material Science with SRL Plasma Ltd (at that time a division of Siddons-Ramset Pty Ltd) and Nufarm Pty Ltd.

The project started in 1990, and CSIRO's involvement ended in 2000. CSIRO scientists had been experimenting with laboratory scale systems for some years prior to 1990. CSIRO jointly owned the technology with SRL Plasma; last year SRL Plasma/BCD Technologies bought out CSIRO's share.

The following PLASCON plasma waste destruction plants have been installed:

- Two at Nufarm's Melbourne plant, in 1992 and 1995 respectively, destroying the waste liquid from production of 2,4D herbicide. These are integrated into the production process; without such a destruction facility, the 2,4D production would have had to have closed due to concerns about the emissions.
- One at the Australian National Halon Bank in Melbourne, in 1997, destroying Australia and NZ's stockpiles of halons and CFCs. Over 1500 tonnes of these ozone-depleting substances have been destroyed.
- One at BCD Technologies in Brisbane, in 1997, destroying PCBs, insecticides, the liquids used to extract toxic chemicals from contaminated soils, etc.
- One at DASCEM Europe, Peterlee, UK, in 2003, destroying Europe's stockpile of halons. This plant has subsequently been transferred to Quimobasicos company at Monterrey Mexico, where it destroys the trifluoromethane formed as a by-product of HCFC production. Trifluoromethane is a greenhouse gas and payments for this are through the Kyoto Protocol Clean Development Mechanism.
- Four at Mitsubishi Chemical Company, Yokkaichi, Japan, in 2004, destroying the company's stockpile of PCB-kerosene mixtures.
- One in Ohio, USA, in 2006, destroying halons.

The use of PLASCON to destroy such wastes ensures thorough destruction with extremely low emissions, thereby minimising the environmental impact of the destruction process.

The depletion of the stratospheric ozone layer has had, and continues to have, a negative impact on the health of world's population, on animals and on agriculture, due to the resulting increased levels of ultraviolet radiation reaching the earth's surface. Australia is more adversely affected than most countries, because of its proximity to the ozone hole over Antarctica, and the already high ultraviolet radiation levels over most of the country. Continuing depletion of the ozone layer would have disastrous implications for health and agriculture.

The successful management and ultimate destruction of stockpiles of ozone-depleting substances is an essential component of the implementation of the international treaty, the Montreal Protocol, which will allow the regeneration of the ozone layer over the next 50 years. The development and deployment of a process for the destruction of halons and CFCs is thus a major contribution to the long-term health of the world's population. The PLASCON process destroys ozone-depleting substances to a level 100 times greater than specified by the Montreal Protocol. This is driving efforts to increase the stringency of ozone-depleting substance destruction criteria, thereby further reducing the impact of ozone-depleting substance destruction on the environment.

The recent application of PLASCON to the destruction of the greenhouse gas trichloromethane (with a global warming potential of 11,700, compared to one for carbon dioxide) indicates the potential of this technology to reduce greenhouse emissions at source.

PCBs do not decompose readily in the environment; moreover they can travel long distances in the air. Health effects that have been associated with exposure to PCBs include acne-like skin conditions in adults and neurobehavioral and immunological changes in children. PCBs are known to cause cancer in animals. Effective destruction of stockpiles is imperative to remove the possibility of environmental and human health effects. The availability of the PLASCON technology in Australia and Japan, ensures thorough, controlled destruction of PCB stockpiles, with negligible emissions from the destruction process.

The development of the PLASCON technology to destroy Nufarm's waste stream from 2,4 D production has had both environmental and economic benefits. Environmentally, the use of the PLASCON process has prevented the release of around 1 tonne per day of toxic organic chemicals, including dichlorophenols, toluene and dioxins, into the environment. Economically, the development of PLASCON saved the company having to close down this profitable production process. The availability of an effective and reliable on-line destruction technology has allowed Nufarm to alter the production parameters to reduce production costs, while at the same time reducing emissions of toxic substances to negligible levels.

The cost to the Commonwealth Government of destroying over 1500 tonnes of halons and CFCs amounts to many millions of dollars. Commercial rates for such destruction are approximately US$4000 to $5000 per tonne. The availability of PLASCON has allowed the retention of this money in the Australian economy (there are no other suitable technologies available in Australia). Costs for the destruction of PCBs and other intractable wastes are similar. The Australian economy has recently benefited from use of the PLASCON Tottenham plant to destroy New Zealand's stockpile of CFCs.

The PLASCON technology is now starting to earn significant export dollars to Australia. The sale or licensing of six plants outside Australia, at well over US$1 million each, indicates the potential in this area. The purchase of the technology by DoloMatrix International Ltd is likely to see a further increase in international sales.

SRL Plasma Ltd, whose primary business is PLASCON, operated for 15 years, initially as a division of Siddons Ramset Ltd, and then as a stand-alone company (also under the name of BCD Technologies). SRL Plasma was recently purchased by DoloMatrix International Ltd, a company listed on the Australian Stock Exchange.

There were impediments to effective innovation.

SRL Plasma Ltd strongly restricted publication of results, preventing sharing of information with other researchers. This is likely to have slowed the innovation process.

The contract with SRL Plasma prevented CSIRO from working in the plasma waste destruction field without agreement from SRL Plasma. SRL Plasma management was not cooperative, and this undermined attempts to negotiate with investors on, for example, destruction of medical waste.

Decision-making principles and programme design elements were important.

SRL Plasma Ltd and Siddons-Ramset Pty Ltd had a long-term commitment to the R&D programme, and funded it for some years before the process became profitable. An SRL Plasma Ltd staff member was seconded to CSIRO to work more closely with researchers.

The interaction with Nufarm Ltd, which assigned two chemical engineers to assist with the project, was particularly useful. A pilot-level plant was installed on their site, and over the course of two years the plant was modified and improved to bring it up to acceptable industrial standards.

The availability of researchers from four CSIRO divisions allowed a true multidisciplinary team to be assembled, including physical chemistry, analytical chemistry, electrical engineering, mechanical engineering and plasma physics skills. The managements of the divisions were committed to the project, allowing staff secondments and transfers when necessary.

A strong scientific effort, aimed at understanding the chemistry and physics of the waste destruction process, proceeded in parallel to engineering and development efforts. This proved crucial when adverse results were obtained in the adaptation of the process to halon and CFC destruction. It was found that environmentally-damaging exhaust gases were being produced, but the predictions of physico-chemical models allowed the process parameters to be altered to prevent these emissions.

It could have been done better

More openness about results may have increased the rate of progress. Anecdotal evidence since ownership of SRL Plasma changed hands suggests that their marketing and commercialisation efforts were not optimal. Contractual clauses giving SRL Plasma control over marketing and commercialisation matters, and over all CSIRO work in plasma waste destruction, were ill-advised.

Case study 2: Sustainable water usage

Up until July 2006, ecological economist Dr Mike Young lead a research effort in CSIRO's Land and Water directed at natural resource management and policy. The work of his group is aimed at proposing "innovative solutions to challenging problems, integrating biophysical science and economic theory by:

- understanding values, institutional processes, impediments and opportunities for improved resource use
- collecting the information required to scope and short-list policy options for further development and refinement
- testing and evaluating short-listed options, while carefully considering the likely consequences of potential choices
- trialling and refining options in consultation with stakeholders
- expressing results as recommendations for consideration by policy-makers.

We study policy and economic issues relating to natural resource management both within Australia and internationally, to keep abreast of new developments in a rapidly changing sphere of research."

In September 2005, Dr Young published a report *Managing Change: Australian structural adjustment lessons for water,* together with agricultural economist Dr Jim McColl. The report was written to inform policy in relation to the National Water Initiative and explored structural adjustment in the rural sector in relation to water policy and use.

The report's findings and suggestions included that the nation would be better off if governments directed their support to facilitating and expediting autonomous structural adjustment rather than providing general concessional finance for exceptional circumstances such as drought. It made the statement that "there is a risk that adverse climate change may be mistakenly interpreted simply as 'prolonged drought" and put that virtuously continuous provision of drought 'exceptional circumstance' support to certain 'marginal' agricultural areas may "discourage desirable adjustment of farming systems and business size to that more in harmony with the natural environment. In effect, the provision of exceptional circumstances assistance is in conflict with the requirements of long term sustainable natural resource management."

Such considerations for policy would affect the expenditure of very large amounts of public funds and may drive innovations necessary for long term sustainability of rural industries, environment and communities. Over the last three years, the Howard government was spent approximately $466m on exceptional circumstances payments alone.

When it was released, the report was roundly and publicly rejected by the Minister for Agriculture Fisheries and Forestry Mr Peter McGauran. The Minister's criticism had adverse effects within CSIRO on confidence, morale and the capacity of scientists to speak in the media about their research findings. It is not clear if any of the results of the research were put into practice by governments or taken on board for future action, so there is no direct way to measure the productivity benefit from the research.

However, since the report was published on the web in September 2005, it has been downloaded some 15000 times. Dr Young anticipates that the vast majority of downloads would have been in Australia - it is possible that the controversy in the media over its findings prompted many more people to read the report. So it is likely that the report's information has had a significant impact on thinking and possibly local policy in the Australian rural sector.

At the end of May 2006, Dr Young's group released the report *"Without Water: The economics of supplying water to 5 million more Australians",* which was a study funded by the National Research Flagships program in collaboration with Dr Glyn Wittwer at Monash University. The report analyses different scenarios for the future use of water and directions for research and policy. It concludes that water policy decisions have the capacity to affect regional development and where people live in Australia.

There has been no controversy or media attention to this report. Despite this, has been downloaded 16000 times from the CSIRO website.

Case study 3: Hydraulic fracturing

Dr Rob Jeffrey has lead a CSIRO research effort in the discipline of hydraulic fracturing for over 12 years. The research involves the study of fluid injection into hard rocks at rates sufficient to cause a fluid driven fracture to grow. Hydraulic fracturing is widely used in the petroleum industry to stimulate oil and gas production rates from wells. This area of expertise was developed in petroleum research. Dr Jeffrey's group has also applied their research with remarkable success to coal and hard rock mining even though this was not what the group was initially funded for.

Dr Jeffrey currently leads a research effort of $2 million per annum which currently directly engages with about 10 companies in Australia and overseas. Dr Jeffrey started as an early career scientist in a group comprising two technicians and two other research scientists working on coal seam methane. He built the hydraulic fracturing team up over a period of 15 years to 6 researchers and 3 technicians with specialised equipment for lab and field research and testing. A significant factor in their success has been the specialist capability of the technical support staff on the team.

Over the period Dr Jeffrey's team has been prolific in publishing research papers, with 30 journal papers and 50 conference papers published since 2000, on both theoretical and practical aspects of the research. They have been recognised both nationally (CSIRO Medal 2001) and internationally (MTS visiting professor at the University of Minnesota in 2004) for the advances they have made for the scientific discipline.

It took 10 years to complete the initial research that established Dr Jeffrey's group as world leaders in hydraulic fracturing and a similar time length of time to establish a track record and relationship with private companies that opened the way for realising the innovative potential of the research. There has not been a full assessment of the productivity gains from this research team for industry but informal estimates of their hydraulic fracturing in mining research have valued it at no less than $20 million annually.

Case study 4: Gas to liquids

As the cost of petrol rises and the national demand for cheap energy remains, major innovations in fuel sources and production will be needed to maintain a robust economy. Australia’s reserves of crude oil are dwindling. The science of conversion of natural gas to liquid products (known as Gas to Liquids or GTL) is particularly relevant in Australia’s context as Australia has vast reserves of relatively hard to access natural gas. Conversion of these reserves to liquids will lessen our dependence on imported crude oil and will help secure Australia’s energy future. Federation Fellow Prof David Trimm has been building a new research group in CSIRO since the beginning of 2001 to work on natural gas processing and gas to liquids processes.

CSIRO had a gas to liquids research effort previously in the former division of Coal and Energy Technology. Their work was directed at a number of approaches to finding simpler, cheaper process systems as well as catalysts for the chemical conversion process. Their work was funded mainly by BHP Limited and the Energy Research and Development Corporation (ERDC), but when the ERDC was shut down and BHP Ltd pulled out of the research area in the early 1990s, the scientific staff were made redundant. CSIRO did no work in this area of national significance until Prof Trimm was appointed to CSIRO at the end of 2000. Prof Trimm was a very senior academic close to retirement at the time. He was awarded a Federation Fellowship in 2002.

The market for such scientific expertise in petroleum has been tight for the past decade and the current skills shortage is exacerbating the problems with recruitment of staff with skills and knowledge of the area. Consequently, Prof Trimm has been building his group by employing Post Doctoral Fellows to establish a new capability. Since 2001, two Post Doctoral Fellows have been trained and two new Post Doctoral Fellows were appointed in the first half of 2006. The research team is currently comprised of Prof Trimm, one research scientist, one technical officer and the two new Post Doctoral Fellows as well as an oil and gas business analyst.

The group is funded primarily by the Federation Fellowship with additional money coming from the Victorian State Government by way of the Science and Technology Initiative, CSIRO appropriation funding (flagship and other) and industry. It is publishing its research at a rate of nine articles per year. It is beginning to establish a reputation and relationship with industry such that it is now working closely with Chevron through the WAERA initiative. It also has links with Woodside, Orica and Multiplex. The innovative potential of the group will take many years to be realised, but the economic and social impacts for Australia are likely to be massive, with one patented process alone having the potential to save small to medium gas processing operators $10 to $50M in operating expenditure annually.

Case study 5: Steel and alumina manufacturing research

Manufacturing in Australia encompasses a wide range of business activities, from clothing manufacture to beer production to minerals processing. In 2005 the value of its total output was worth $96 billion, or 11% of Australia's GDP. The most recent overview of growth in Australian industries released by the Australian Bureau of Statistics on 5 July 2006 showed that while the manufacturing sector as a whole is in decline, manufacture of machinery and equipment is showing the biggest growth in the sector. Despite perceptions that motor vehicle manufacture dominates the sector, machinery and equipment manufacturing employs 244000 people in Australia, almost ten times more than car manufacturing.

The CSIRO Manufacturing and Infrastructure Laboratory at Woodville in South Australia has been well placed to support the state which relies the most on manufacturing in its economy. Since 1975, the laboratory has supported an extensive long term research effort into wear-resistant materials used in mining and mineral processing, usually cast or welded materials - alumina and steel. The research has related to equipment for pretty much anything that is dug up out of the ground and has therefore underpinned the current Australian resources boom.

The Woodville laboratory has been at the forefront of this research for twenty years. It is slated for closure in April 2007.

Our members in this area of research have worked closely with a large number of manufacturers to support their needs. The members have reported consistently over the years that Australian manufacturers cannot support large R&D projects and, apart from their involvement in the Welding Co-operative Research Centre, they have had to rely on relatively small investments in their research. As they have been required to secure industry funding for the vast majority of project research, this has limited the work they have been able to undertake and consequently the innovations and outputs they have been able to deliver for productivity gains.

In his 2006 book *The Australian Miracle – An Innovative Nation Revisited*, Thomas Barlow describes the evolution of Australian manufacturing as a niche industry of small to medium companies. He credits their success as being small and adaptable in a highly competitive global manufacturing environment that has relied on scale. He sets out the movement of low-technology industries in Australia to the use of advanced technologies and adaptation to

Australian circumstances and describes the advantage this has conferred - as manufacturing businesses operate on small profit margins, any innovation makes a difference for them.

Australian manufacturers have been criticised repeatedly in the media for not investing enough in R&D. The industrial structure of Australian manufacturing is dominated by smaller businesses that, according to our members, have not been encouraged enough to access the research capability in heavier metals available at Woodville. The manufacturing demand for research has been very much up and down according to the immediate research needs of each company.

CSIRO's public announcement about the closure of the Woodville laboratory claimed that its metals manufacturing research effort would be consolidated in light metals and alloys at Clayton in Victoria. The potential for researchers at CSIRO Woodville to work with businesses on the research they need is greater in South Australia than in Victoria. In fact, no more than 3 or 4 of the 36 staff at Woodville will relocate to Victoria. Most of the workforce will be lost to Australian manufacturing research as they have very little in the way of opportunities for employment outside of CSIRO.

There are very few private or dedicated manufacturing research facilities in Australia, particularly since BHP Ltd and Telstra closed down their research laboratories. Unlike medical research, industrial research does not receive the private endowments or trusts to set up such facilities, and where businesses have taken the step to establish a research centre, the funding has not been continued for the longer term. Mr Ted Roach, Managing Director of Roach Industries Pty Ltd, has argued publicly for commercial research centres as the way for Australia to provide innovation to support SMEs develop elaborately transformed manufactured goods for export.

In 2005 the South Australian government announced a major funding initiative to set up the Mawson Institute for Advanced Manufacture at the University of South Australia. The money was only allocated to capital structure, not to put researchers in the building to do the work. Even though talks were held with CSIRO about a staffing arrangement, when the announcement was made, the government failed to make provision for CSIRO to be included in the funding.

CSIRO has moved to big projects in manufacturing directed at light metals such as magnesium, titanium and new light alloys. The move follows international trends in research but leaves a gap in the national R&D effort for innovation for current manufacturing. As light metals are unlikely to supplant heavier metals such as steel in our heavy industries, the move may have longer term implications for the international competitiveness of the mining industry.

The CSIRO decision to close their Woodville laboratory was announced before CSIRO had completed a review of manufacturing research. After the announcement was made in April, the Federal Parliament announced a House of Representatives inquiry into the state of Australia's manufacturing industry, to review the situation now and beyond the resources boom. Its findings have not yet been released. In July, State and territory manufacturing ministers agreed to hold a national summit on the issues facing the manufacturing sector. The need for more R&D and commercialisation of R&D will be on the terms of reference. The scientists at Woodville are still working there but their time is running short.

Case study 6: Sheep and wool production

Since its inception, CSIRO has been a major contributor to Australia's wool research effort. However, in the last decade, the number of active wool researchers has declined significantly, both at CSIRO and other research institutions. Research into meat is perceived to have superior prospects, due to current market conditions and has consequently been better supported by industry partners. The focus of wool research has narrowed to mainly off-farm research such as wool processing.

This narrowing of focus threatens to diminish Australia's long-term wool production competitiveness if talented researchers leave the sector and are not replaced by researchers with similar knowledge and capabilities. Within CSIRO, wool researchers have become accustomed in recent times to management comments such as 'the work is too far into the future to have immediate impact on-farm'. This attitude ignores the fact that much of the recently terminated wool research had a 10-20 year time horizon before it had a significant impact on the wool industry.

On-farm wool research is just as relevant to Australia today as it has ever been. For example, approximately a third of the Australian wool clip is shrink-proofed at a cost in excess of $1.40 per kg. The most popular process also uses chlorine, which is becoming subject to increasingly severe economical restrictions and may also be banned in the EU. One Australian industry processor estimated that 'the average wool could achieve another 50 cents per kg if they could breed sheep to meet the shrinkage requirements'.

Therefore, the research direction should be to switch wool production from a raw commodity material to producing wool on the sheep for specific fabric types. However, a CSIRO project to breed sheep for wool with desired fabric outcomes and intrinsic fibre qualities is likely to cease, as a result of changes in top-down research priorities. This is despite promising early results and the distinct customer/consumer relevance of the project.

This situation has also arisen due to a lack of appreciation of the interplay between public R&D and external investment from clients such as Australian Wool Innovation Ltd (AWI). AWI currently sees the sheep as not playing a major role in improving the intrinsic qualities of wool and that changes to the intrinsic qualities are best made off-farm with chemical or processing intervention.

This perspective has arisen because wool processors see AWI as their cash R&D supplier with levies obtained from wool growers to support processing improvement. There is a lack of incentive for them to provide R&D funds to CSIRO when the research comes at no cost at the processing end. Despite this, the wool industry, particularly wool growers, still have a crying need to improve the intrinsic performance of wool, but are unwilling or unable to fund R&D for on-farm research.

CSIRO's relationship with AWI has consequently suffered with potentially major effects on its research capability in the livestock industries. This situation reinforces the importance of public R&D maintaining long-term capabilities in order to maximise preparedness and withstand fluctuations in market trends and perspectives of external partners.

Importantly, sustaining wool research has also had vast social consequences in Australia, where maintaining viable wool industries have been critical to the survival of many rural towns. Wool production traditionally requires higher labour inputs than cattle production. The shift from sheep to cattle has therefore had a significant impact on population dynamics, particularly in strict pastoral areas. This is rarely considered when evaluating the potential impacts of public R&D into the sheep and wool research areas.

Case study 7: Sustainable farming in practice

Mr John Ive worked in CSIRO over an extended number of years in the division of Sustainable Ecosystems and its predecessors in the ACT. Working at a practical level on aspects of ecology and farming systems, Mr Ive was a significant leader of research in Agricultural Landscapes up until early 2006.

In his work on the Heartlands Initiative for CSIRO, a long term research commitment, Mr Ive was instrumental in forming collaborations among CSIRO divisions and rural communities and extending the research of the division into the rural community.

But Mr Ive's most recognised contribution to productivity was in the way that he and his family were able to apply his understandings and learning from the R&D in CSIRO in his own merino breeding operation. The Ive family have used integrated environmentally sustainable approaches to convert a degraded, severely salt damaged property in southern NSW into a best practice operation that has become a national showcase for profitable, environmentally sustainable farming.

The property 'Talaheni' has been recognised as a significant model both nationally and internationally. Its awards have included a UN Award for Outstanding Service to the Environment in the 2004 World Environment Day Awards and the CPA Triple Bottom Line Award. Mr Ive has been a frequent guest speaker at agricultural and farming practice conferences around Australia and model farm has been presented to the wider agricultural community in publications such as *Australian Landcare*.

The innovations successfully applied at Talaheni has fed back information and learning into the R&D effort.

There has been no estimate of the economic gains of the Ive family's model for agriculture but it is driving autonomous change in the farming sector such that the benefits will be long term and social as well as environmental and economic. It was an unplanned consequence of publicly funded R&D in the national interest.