Nath, Romy (REPS)

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Sent:	Friday, 29 April 2005 3:05 PM
To:	Committee, SCIN (REPS)
Subject:	[Submission] HOR Standing Committee: Marketing Our Innovations

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April 29, 2005

The Secretary
Standing Commission on Science and Innovation
House of Representatives
Parliament House
CANBERRA ACT 2600

Re HOR Enquiry – Marketing our Innovations

I've been privileged to chair a Working Group on the Metrics of Commercialization for the DEST Coordination Committee on Science and Technology for the period 2003-2005. The Group includes representatives from major government organizations involved in Australia's research funding and the carrying out of research and commercialization activities. Our final report was presented on Apr 15 in Canberra and an interim copy approved for publication is attached to this submission. The final copy will be shortly published by DEST, however this will be beyond the date for submissions to the HOR Standing Committee on Science and Technology.

The key recommendation of our report is to broaden the definition of 'commercialisation' to a more encompassing 'commercial potential' which is more reflective of an Australian situation.

Consequently the report proposes metrics to include measures relating to research consultancies and contracts, and knowledge and skills transfer to the private sector. However, in carrying out our work, the WG extended its brief by:

- mapping the overall process of publicly funded research commercialisation,

- outlining the broad interaction and impacts between publicly funded research institutions and private sector enterprises (both existing and emerging businesses),

- highlighting the potential impacts on the Australian economy and Australia's global trade and investment.

It was beyond the brief of the Working Group to address critical issues beyond the metrics project which would be of interest to the HOR Standing Committee. These issues are listed below and outlined in context in the attached map, "Beyond Metrics":

Publicly Funded Research Agencies (PFRAs) Critical Issues:

> Symbiosis: This is really the 'nut issue' since we need staff who can talk the language of both supply (research) and demand (business) sides, facilitate meaningful communication, and deliver against expectations. The PFRAs must develop more of a service mentality as opposed to a previous entitlement mentality.

> Refocus/reorganize the Business Liaison and Technology Transfer Offices: traditionally these offices have focussed on licensing and spin-out initiatives. In refocussing, the Business Liaison and/or Technology Transfer offices must seek to:

  o Establish business-driven organizations with 'freedom to operate' under prevailing enterprise-wide labour agreements.
  o Improve business processes (particularly those relating to SME service, central entry point etc) and design processes that are common across service lines.
  o Manage projects and access to capabilities and facilities.
  o Significantly increase income from analytical, contract research and consulting opportunities – to cover initial costs of operations.
  o Coach/mentor junior managers and scientists to nurture future business leaders from within the ranks of technical staff.

> Commercial Board Representation: augment/change the primarily academic base of PFRA boards to include 'practitioner advice' from experienced emerging business and industry people to facilitate enterprise creation. Currently, the majority of NEDs on Boards are NOT from the private sector.

Enterprise Critical Issues:

> Corporate growth and exits: we cannot not lose sight of a key business driver – growth of stockholder interests and the need for 'suitable exits' for early stage investors.

> Talent pool: people to staff, operate and successfully execute new business and enterprise opportunities.

> Access to Capital: cash to build, sustain, and launch new enterprises, and

> Investment Incentives: particularly additional reforms in taxation to encourage and attract angel investment.

Strategic Issues:

➤ <u>Sector variations:</u> business cultures, practices, and timelines vary widely across different industries.

➤ <u>Market introductions</u>: we need partners who 'speak the language' to take our enterprises to global markets, with

➤ <u>Market knowledge:</u> ways of doing business, and receptivity to innovation and new players vary widely between industries and markets.

➤ <u>Track record:</u> 'what have you done' is always the first question when seeking partners, raising money or going global.

Respectfully submitted,
Robert Muir
Chair CCST Working Group Metrics of Commercialisation.

Attachments: Interim Copy Metrics of Commercialisation Report
Map-Beyond Metrics Critical Issues

METRICS FOR RESEARCH COMMERCIALISATION

**A Report to the
Coordinating Committee on Science and Technology**

15 April 2005

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Figures

Tables

Abbreviations and acronyms

AIMS	Australian Institute of Marine Science
ANSTO	Australian Nuclear Science and Technology Organisation
ARC	Australian Research Council
AUTM	Association of University Technology Managers (USA)
BAA-BOFTSI	Backing Australia's Ability—Building Our Future through Science and Innovation
CCST	Coordinating Committee on Science and Technology
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEST	Department of Education, Science and Training
DITR	Department of Industry, Tourism and Resources
HE-BI	Higher Education—Business Interaction Survey (UK)
IP	Intellectual Property
MDQ	Management Data Questionnaire
MoC	Metrics of Commercialisation
NHMRC	National Health and Medical Research Council
NSRC	National Survey of Research Commercialisation
PFRA	Publicly Funded Research Agency (ANSTO, AIMS, CSIRO)
R&D	Research and Development
SPRU	Science and Technology Policy Research Unit (UK)
WG	Working Group (on Metrics of Commercialisation)

Working group and terms of reference

Members

- Mr Rob Muir (Chair), Managing Partner, Prometheus Equity Partners

- Dr Evan Arthur, Group Manager, Innovation and Research Systems Group, Department of Education, Science and Training

- Ms Tricia Berman, General Manager, Innovation Policy Branch, Department of Industry, Tourism and Resources

- Mr Simon Sedgley, Director, Policy and Planning, Australian Research Council

- Mr Zack Herlick, General Manager, Australian Growth Partnerships, Commonwealth Scientific and Industrial Research Organisation

- Ms Helen Fullgrabe, Principal Executive Officer, National Health and Medical Research Council.

Terms of reference

The terms of reference for the Working Group were to:

1. Determine appropriate measurements/indicators to monitor economic benefit flowing from commercialisation of research funded by the public sector.

2. Perform a stock take to identify work conducted in Australia and elsewhere to develop and apply metrics of commercialisation.

3. Develop a priority list of data collection gaps that can be addressed by using resources available to CCST members.

The Working Group will prepare a report to be presented to the CCST. The Group will have the task of developing a set of metrics of commercialisation to position each member agency/ department to provide a consistent approach to measuring the benefits from investment in science, engineering and technology. The measures will be relevant to the implementation of National Research Priorities, CSIRO's Flagship programmes and the Triennial Agreements with the science agencies. It will consult with key external stakeholders, specifically the Publicly Funded Research Agencies (PFRAs). It will also conduct public consultation and undertake studies and analyses. The Group will also be able to draw on the recent outcomes of the National Survey of Research Commercialisation.

Key points and recommendations

The Coordinating Committee on Science and Technology (CCST) established in November 2003 a Working Group (WG) on Metrics of Commercialisation (MoC). This Report details the WG's findings and recommendations.

After examining current practice in Australia and overseas, and analysing 22 submissions from organisations, the WG has concluded that current metrics for commercialisation of publicly funded research need to be extended to reflect a broader understanding of the commercial and economic benefits of research commercialisation.

Current metrics emphasise the commercialisation of intellectual property (IP), especially through patents, licenses and spin-out company formation. These data capture only a small portion of the commercially significant interactions that take place between the publicly funded research sector and private enterprise (i.e. including current and emerging business). The WG proposes that the metrics be expanded to include measures relating to research consultancies and contracts, and the development and deployment of appropriate skills.

In addition to making three recommendations, the WG has identified several areas for further examination (details in section titled *Issues for further study/development*), including:

- further develop policy and performance monitoring methodologies to capture researcher-industry interactions, including the role of knowledge and skills transfer to private sector enterprises

- examine the links between policy, funding decisions and research commercialisation metrics

- review the *National Principles of Intellectual Property Management for Publicly Funded Research* to ensure they reflect current and emerging IP practice and the needs of the research and innovation system.

Recommendations

Recommendation 1: That for Australia's publicly funded research, 'research commercialisation' be defined as the means by which universities' and PFRAs' research generates commercial benefit, thereby contributing to Australia's economic, social and environmental well-being. This is achieved through developing intellectual property, ideas, know-how and research-based skills resulting in new and improved products, services and business processes transferable to the private sector.

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Recommendation 2: That the 14 metrics covering IP, contracts and consultancies, and skills development and transfer in Table 3 be adopted as the basis for future data collection and assessment relating to research commercialisation across Australia's publicly funded research institutions.

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Recommendation 3: Building on the metrics in Table 3, that a comprehensive data collection strategy for research commercialisation metrics be developed. The strategy should:

- maintain the existing time series data for the core indicators developed through the National Survey of Research Commercialisation

- address any deficiencies in data quality so as to improve data timeliness, availability and/or reliability (including those identified in this Report)

- wherever possible, draw upon existing and reliable third-party data to reduce the burden on respondents and to ensure consistency.

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Introduction

Purpose and scope

On 7 November 2003 CCST agreed to establish a Working Group on the Metrics of Commercialisation. Membership of the WG was drawn from the Department of Education, Science and Training (DEST), the Department of Industry, Tourism and Resources (DITR), the Australian Research Council (ARC), the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the National Health and Medical Research Council (NHMRC), with the Chairman coming from the Australian Nuclear Science and Technology Organisation (ANSTO). The WG membership and terms of reference are at page 3.

The WG's task was to identify measures of the commercial benefits flowing from the investment in publicly funded research. These are important in helping to demonstrate the relevance and value of public investment in research. The WG hopes that its work will provide a basis for the development of a more consistent approach to measuring research commercialisation among CCST member agencies/departments.

In carrying out its work, the WG extended its brief by:

- mapping the overall process of publicly funded research commercialisation

- outlining the broad interaction and impacts between the publicly funded research institutions and private sector enterprises (both existing and emerging businesses)

- highlighting the potential impacts on the Australian economy, its global trade and investment.

This is the final report of the WG. A preliminary report was presented to the CCST at its meeting on 5 November 2004.

Methodology

The WG met on several occasions throughout the period of the project. The Chairman met with the Secretariat to develop the analysis and prepare this report. Various issues were dealt with via email and teleconferencing with individual members of the WG.

The WG invited submissions from interested organisations; a copy of the invitation to provide submissions is at Appendix 1. A list of the 22 submissions received is at Appendix 2. In total over 130 metrics were proposed in the submissions received. A separate analysis of metrics nominated in the submissions received by the WG is available on the CCST website, <http://www.dest.gov.au/science/ccst/>. A summary of that analysis is provided in *Appendix 2: Submissions received.*

In addition to analysing the metrics proposed in the submissions, the WG considered other key sources, including in particular:

- metrics used in the *National Survey of Research Commercialisation* (NSRC) for the years 2000, 2001 and 2002 (which are based on the metrics used in the annual survey conducted among universities and other research organisations in the United States and Canada by the Association of University Technology Managers—AUTM)

- work carried out by Dr John Howard for a report to DEST on *The Emerging Business of Knowledge Transfer: From Research Commercialisation to the Commercial Management of Knowledge Services*[1]

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[1] The Report is currently awaiting approval for release.

- a Report from the Science and Technology Policy Research Unit (SPRU) to the Russell Group of Universities in the United Kingdom titled *Measuring Third Stream Activities* (2002).

Criteria for assessing a system of metrics

The WG believes that in the Australian context, an effective set of research commercialisation metrics should reflect the nation's particular scientific, environment, health, economic development, and related global trade and investment issues.

Australia's research commercialisation metrics should be:

- *Specific*: by focusing on a clearly defined conception of 'the commercial benefit of publicly funded research', and indicating performance across different types and fields of research and modes of commercialisation.

- *Measurable*: by using tangible factors in readily available statistical, accounting and other information systems.

- *Actionable*: by highlighting matters of importance regarding the commercial benefits of research from the viewpoint of policy-making, monitoring and evaluation. This includes identifying key outcomes, outputs and inputs.

- *Reliable*: by being based on data that is consistent and robust.

- *Timely*: by including leading, lagging and real-time data that can be obtained in a reporting cycle that meets to decision-making and monitoring needs of government.

- *Cost effective*: by being in number sufficient to the task, and not placing unreasonable imposts on those providing the data.

- *Efficacious:* by encouraging desired behaviours and avoid encouraging undesirable behaviours.

The analysis of metrics in this Report is based on these criteria (see section *A proposed system of metrics* and *Appendix 6: Assessment of the proposed core group of metrics*).[2]

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[2] In addition, the WG also identified four categories to organise and analyse metrics proposed in submissions. These were: *Leading* (likely future economic, social and environmental benefits); *Real time* (current performance); *Lagging* (past performance); *Learning* (rate at which performance is improving).
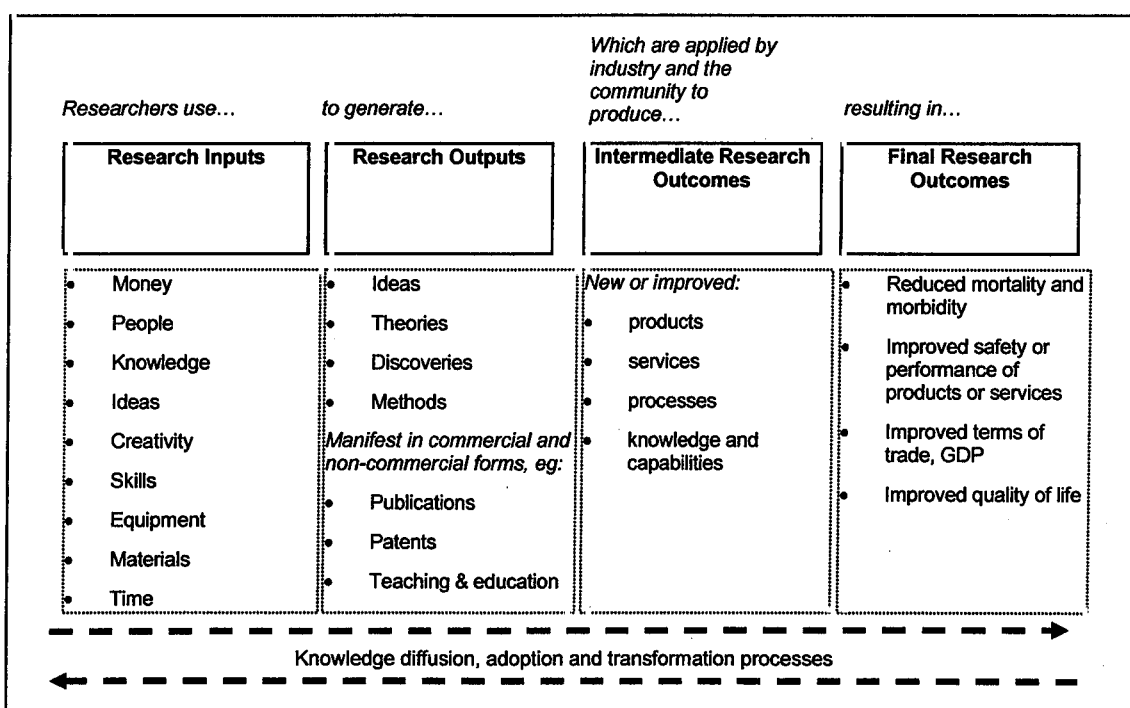
Context

The research system

The overall goal for governments is to manage research and innovation as a *system* that will generate the greatest possible return to the community in the form of economic, social and environmental benefits.

The programme logic of the research system is depicted schematically below in Figure 1, below. While this figure depicts a linear progression, the system is actually far more fluid and iterative, involving complex linkages and feedback loops.

Figure 1: Research inputs to final outcomes

Researchers use...	to generate...	Which are applied by industry and the community to produce...	resulting in...
Research Inputs	**Research Outputs**	**Intermediate Research Outcomes**	**Final Research Outcomes**
• Money • People • Knowledge • Ideas • Creativity • Skills • Equipment • Materials • Time	• Ideas • Theories • Discoveries • Methods *Manifest in commercial and non-commercial forms, eg:* • Publications • Patents • Teaching & education	*New or improved:* • products • services • processes • knowledge and capabilities	• Reduced mortality and morbidity • Improved safety or performance of products or services • Improved terms of trade, GDP • Improved quality of life

Knowledge diffusion, adoption and transformation processes

Source: based on Geisler, E 2004, Measuring the impacts from public sector science and technology: new methods, cited in Allen Consulting Group (2005), *Measuring the impact of publicly funded research*, Report for DEST, (p. 2). Available at: <http://www.dest.gov.au/resqual/publications.htm>.

As Figure 1 suggests, research can deliver social, economic and environmental outcomes in a range of ways. One recently compiled list—which is by no means exhaustive—includes:

- new products and new processes that can help reduce costs or improve public policy and societal structures

- incremental improvement in existing products, processes or services

- education and training of research workers and business professionals, and also university graduates and the community more generally

- increased ability to participate and integrate cutting edge research knowledge developed elsewhere in the world at a very early stage.[3]

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[3] Allen Consulting Group (2005), *Measuring the impact of publicly funded research*, Report for the Department of Education, Science & Training, Canberra. Available at: <http://www.dest.gov.au/resqual/publications.htm>.

Our understanding of the multiple benefits of research and the multiple paths by which research is brought to adoption or to otherwise exerts an impact and therefore generates value for society and the economy is expanding rapidly. This is borne out in the 2005 DEST-commissioned Allen Consulting Group report on *Measuring the Impact of Publicly Funded Research*. The Report attempts to capture the range of indicators that would be necessary to measure both the quality and diffusion of publicly funded research. Appendix 3 reproduces a table of the various suggested indicators from the Allen Consulting Group Report.

Economic context

Historically, Australia has relied on primary resources as the basis of its national economic performance. In recent decades, however, the Australian economy has diversified. There is now a stronger emphasis on the production and export of high-technology manufactured goods, as well as sophisticated services. This has contributed to growth of an average of seven per cent in Australia's exports over a ten-year period. An increasing level of export of elaborately transformed manufactures has driven the growth in Australian merchandise exports. Australia has relatively high numbers of research scientists and engineers and a strong record of innovation and invention. It is therefore well placed to take advantage of growing international markets—especially in Asia—for sophisticated manufactures and solutions.[4]

Australia's export profile has changed from its traditional reliance on primary resources to include service areas such as education and training. For example, in 2004 education and training was Australia's sixth highest export earner with exports totalling $5.7 billion.

Overall economic performance, as measured by such factors as growth in GDP, business investment, employment and terms of trade etc has recently been very strong in Australia.[5] One of the consequences of strong economic growth, however, has been continuing pressure on the national current account, with a deficit in the September 2004 quarter of over $13 billion.[6]

In this environment of sustained growth and high relative demand for imports and foreign capital, it is important that Australia's capacity to bring ideas to market and develop a strong innovation-based economy is maintained. One component of this involves ensuring that publicly funded research is carried out effectively and efficiently. This encompasses the objective that, where appropriate, commercial benefit for the community is generated by the development and deployment of new or improved products, services and business processes.

Monitoring the performance of research commercialisation through a system of metrics will therefore help inform national policies and organisational practices that support and extend the economy.

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[4] Department of Foreign Affairs & Trade 2004, *Australia Now*, [online] <http://www.dfat.gov.au/facts/new_aust.html>, accessed 24/12/2004.

[5] Australian Government 2004, 'Budget Statement 3', *2004-05 Federal Budget Papers*, [online] <http://www.budget.gov.au/2004-05/bp1/html/bst3.htm>, accessed 24/12/2004.

[6] Australian Bureau of Statistics 2004, '5302.0 Balance of Payments and International Investment Position, Australia', released 29/11/2004.

Current metrics for research commercialisation

Most approaches to measuring 'research commercialisation' in Australia apply a definition similar to that used in DEST, where for statistical and data collection purposes 'research commercialisation' is defined as 'the processes that generate commercial returns via income and capital gains, income from licences and revenue from sales of new products and processes from research conducted.'[7]

This definition is in accord with the approach used by the US Association of University Technology Managers (AUTM) in their licensing survey. The AUTM Licensing Survey is the most internationally recognised and widely compared standard of data on the transfer of academic research for commercial application. However, the data that AUTM collects is largely driven by the impacts of the US Bayh–Dole legislation, by which universities and not-for-profit research organisations acquire rights to IP developed with Government funding. The AUTM data is limited to research outputs which are, or stem from, 'protected' intellectual property rights— including patents, licences and the business generated from them. Due to the registered nature of IP, these outputs are easy to assemble and analyse. This suite of indicators is therefore the most commonly used method internationally, for measuring research commercialisation success.

The AUTM Survey's methodology forms the basis for the Australian equivalent, the *National Survey of Research Commercialisation* (NSRC), which was conducted by the ARC, the NHMRC and CSIRO for the year 2000, and by DEST for 2001 and 2002.

In the most recent edition of the NSRC (released in October 2004), the survey included the ANSTO, Defence Science and Technology Organisation (DSTO) and the Australian Institute of Marine Science (AIMS). Unlike the previous survey, data relating to Cooperative Research Centres (CRCs) was obtained from the CRCs themselves rather than through university partners.[8]

International trends and practices

In a highly competitive global environment policy makers are increasingly looking at methodologies to capture the performance of government funded research. In most countries this is generally done by counting narrowly defined research performance outputs which generally are captured in activity measures such as patents, licences, start-up companies etc. Many countries have undertaken studies considering a broader range of indicators.

Details of international trends and practices are at *Appendix 4: International trends and practices.*

Table 1 below summarises the metrics most commonly reported by Australian publicly funded research institutions. While there are some metrics that relate to outputs and outcomes, these are generally less frequently and less comprehensively reported on. Overall, current research commercialisation metrics place heavy emphasis on the identification, sequestration, protection and exploitation of IP and focus much more strongly on inputs and processes than on outcomes.

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[7] DEST 2004, *Definitions and Methodological Notes—Statistics on Science and Innovation*, p. 28. Suggested changes to the definition of research commercialisation are taken up later in this Report, under *Redefining 'research commercialisation'*.

[8] A discussion of data issues relating to CRCs in the NSRC is provided later in this Report, under *Data collection gaps*.

Table 1: Major current reported metrics of research commercialisation

Main data groups	Supply side: Publicly Funded Research Sector		Demand side: Business & Community
	Inputs/ Activities	Outputs/ Deliverables	Intermediate Outcomes
Intellectual Property (identification, protection, transfer, exploitation)	1. Patent Applications & Approvals (No of Aust & World) 2. Plant Breeders Rights 3. Invention disclosures 4. Commercialisation Staff 5. Commercialisation Administration	6. Licences, Options, Assignments 7. Royalty agreements 8. Client relations, surveys 9. standards & best practices 10. Equity holdings – Cashed in equity	11. Gross revenue from licensed technology(Licensed or assigned Technology) 12. New products, services or business processes 13. Start-ups/ Spin-outs
Research Contracts & Consultancies	14. Research contracts 15. ARC Linkage Projects 16. Number of Commonwealth grants received	17. Reports 18. Publications 19. Conferences/ Seminars	20. Extent of research collaboration with Industry and business
Skills Development & Transfer	21. Number of undergraduate courses conducted 22. No of staff supervising students	23. Number of research students involved in research project	24. Student employment destination

Outside the area of patents, licenses and spin-outs:

- CSIRO, AIMS and ANSTO collect data contract research activity

- the universities and CRCs report on research training, and

- the rural Research and Development Corporations (RDCs) use other indicators such as skills development, diffusion, dissemination and adoption

- the ARC collects information on the commercial and other benefits to partner organisations (including firms) from collaborative research with universities.

Appendix 5: Some specific approaches in Australia provides more detail on the currently reported approaches to measurement of research commercialisation used by CRCs, PFRAs, RDCs and the ARC.

The similarity of the metrics used by the PFRAs and the additional data collected by the CRCs and RDCs suggests a range of metrics that could form the starting point for the development of a more uniform system for reporting research commercialisation activities. At the same time, differences in disciplines, programme objectives and modes of operation mean that no one system of metrics will suit all. The challenge is to develop an overarching set of metrics that can be adapted to suit the differing circumstances of Australia's publicly funded research institutions.

Data gaps and deficiencies in the current approach

The current suite of metrics captured among most organisations tends to be narrowly focused around intellectual property rights such as patents, and the subsequent business that is generated from the rights.

At this relatively early phase of development, Australia's system of research commercialisation metrics has the following characteristics that need attention or rectification:

- focus on indicators of activity and process, with little attention to outputs and outcomes

- narrow focus on the commercialisation of intellectual property as manifested in patents and similar rights

- doesn't capture other methods of delivering commercial benefit such as through RDCs' work of dissemination or diffusion of contracted research outcomes

- focused on the 'supply side', in that the needs, views, experiences and performance of businesses and industry are not adequately considered or assessed

- insufficiently integrated with other elements of the Australian research and innovation system, particularly the performance and quality of the research system[9]

- dependent on a large and relatively costly special-purpose survey—the NSRC—that tends to be disconnected from other aspects of the national research and innovation system

- heavily influenced by foreign models—especially the AUTM survey methodology—with insufficient reference to specific areas of relevance to Australia's circumstances and policy needs

- does not encompass in systematic fashion all of Australia's publicly funded research institutions or all their efforts to ensure their research produces commercially beneficial results.

In addressing the above data gaps and issues, there remains a need to ensure that any future arrangements for the collecting data are as streamlined as possible. This will ensure that the data collected is relevant not just to the specific programs that it is collected from, but also in regard to informing national policy considerations.

A proposed system of metrics

Redefining 'research commercialisation'

The WG believes that the definition of 'research commercialisation' needs to be recast better reflect the potential impacts on the Australian economy and Australia's global trade and investment. As mentioned above, the current DEST definition for statistical purposes is 'the processes that generate commercial returns via income and capital gains, income from licences and revenue from sales of new products and processes from research conducted.' This definition is somewhat narrow, especially as it does not reflect the range of ways in which publicly funded research activity can provide commercial benefits for industry.

In considering this issue, the WG is aware of DEST-commissioned work by Dr John Howard.[10] Howard identifies four models of commercialising research outputs in Australia's university sector:

1. *Knowledge diffusion*: 'the creation of *awareness* and interest about research findings with a view to promoting adoption, application and use in commercial and industrial contexts'

2. *Knowledge production*: the '*standard model*' whereby there is a linear flow from the creation to the application of knowledge, with the main outputs being 'knowledge products, predominantly intellectual property rights'

3. *Knowledge relationships*: 'the formation of collaborative and cooperative relationships between businesses and research institutions [covering] investments in research infrastructure in its physical, human, relational and structural dimensions'

4. *Knowledge engagement*: 'a process of communicative interaction between universities, business and government ... to address complex problems'.

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[9] See the Issues Paper released in March 2005, *Research Quality Framework: Assessing the quality and impact of research in Australia*, [available at: <http://www.dest.gov.au/resqual/documents/rqf_issuespaper.pdf>].

[10] Howard Partners (Forthcoming), *The emerging business of knowledge transfer: Creating value from intellectual property and services*, Report commissioned by the Department of Education, Science & Training.

Howard argues that the current emphasis placed on the 'standard model' (which he refers to as 'knowledge production') as the path to adoption of research outcomes is restrictive and counter productive. Howard states that while the 'standard model' is 'easily grasped' and its 'outputs easily measured' it does not adequately reflect the wide range of circumstances through which universities impact, or produce benefits, to the economy. Nor does it adequately describe the complex set of relationships, linkages and interactions by the various players, including private enterprise, universities and publicly funded research agencies.

All four models described are present in the Australian research and innovation system and they are contributing in commercialising research outputs. Aside from stating that there needs to be separate approaches to performance indicators for different funding programs, Howard argues that indicators still need to be kept to a minimum and adopted only when they can provide relevant and useful information about the performance of those programs.

It is evident from Howard's analysis—and from the work of the WG—that there is considerable complexity in defining what research commercialisation means, and should mean, in Australia. It is also evident that commercialisation encompasses far more than 'the processes that generate commercial returns', as identified in the DEST definition above. Therefore, in considering the diversity and complexity of the Australian research and innovation system, and taking into account the proposed metrics classes above, the following definition has been developed.

Recommendation 1:

That for Australia's publicly funded research, 'research commercialisation' be defined as the means by which universities' and PFRAs' research generates commercial benefit, thereby contributing to Australia's economic, social and environmental well-being. This is achieved through developing intellectual property, ideas, know-how and research-based skills resulting in new and improved products, services and business processes transferable to the private sector.

Mapping publicly funded research commercialisation

The flow of ideas, technology and innovation among people, enterprises and institutions is essential to the innovation process.[11] To assist in understanding the Australian research and innovation system, the following map of publicly funded research commercialisation has been developed by the WG (Figure 2). The map shows how publicly funded research provides commercial benefits. This process is part of the wider research and innovation system. The map also alludes to the complex relationships flowing from research inputs to outputs and eventually to achieving overall outcomes of 'delivering economic and social benefits' through an interactive process referred to as the 'innovation pipeline' and the 'business feedback loop'.

The map can be read from the top-down or from the bottom-up.

Read top-down (i.e. following the text to the left of the diagram), it shows that the overall desired outcome is 'economic and social benefits through a strengthened national system of research and innovation'.[12] There is a range of systemic and macro-economic indicators of success in achieving this outcome (acknowledging that it is extremely difficult to isolate the causal relationship between publicly funded research and the outcome). These factors are fundamentally affected by Australian business and industry being able to access capital, develop

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[11] OECD (1999), *Managing National Innovation Systems*, Paris.

[12] This description of the outcome is derived from the relevant outcome statements for DEST and DITR.

new business and expand current business. This is done through the formation of new companies and joint ventures and the development of new markets, as well as through the expansion or adaptation of existing firms, the expansion of existing markets, or improvements to existing products, services and processes.

In the context of the commercial application of research, these new or improved businesses are created on the basis of a variety of outputs, including spin-out companies, the licensing of IP, contracted research, facilities access and consultancies, and the development of an appropriate talent pool in the business sector, as well as among researchers. These outputs constitute the primary commercial benefits of research conducted in publicly funded research institutions, including PFRAs, universities, and Medical Research Institutes (MRIs). These organisations link to business and industry through the 'innovation pipeline'—delivering ideas, inventions and know how to industry—and through the 'business feedback loop'—which provides information to the research institutions on the research needs of industry, and financial support in the form of, for example, licence fees, investment, and research contracts. It is through a variety of factors that public sector research institutions seek to generate research that is commercially beneficial, including research grants and government programmes, strong basic and applied research, various collaborative programmes and activities, providing education and skills development to researchers and to industry, developing partnerships internationally and with business, and ensuring they have effective commercialisation processes, policies and support in place.

Figure 2: Map of publicly funded research commercialisation
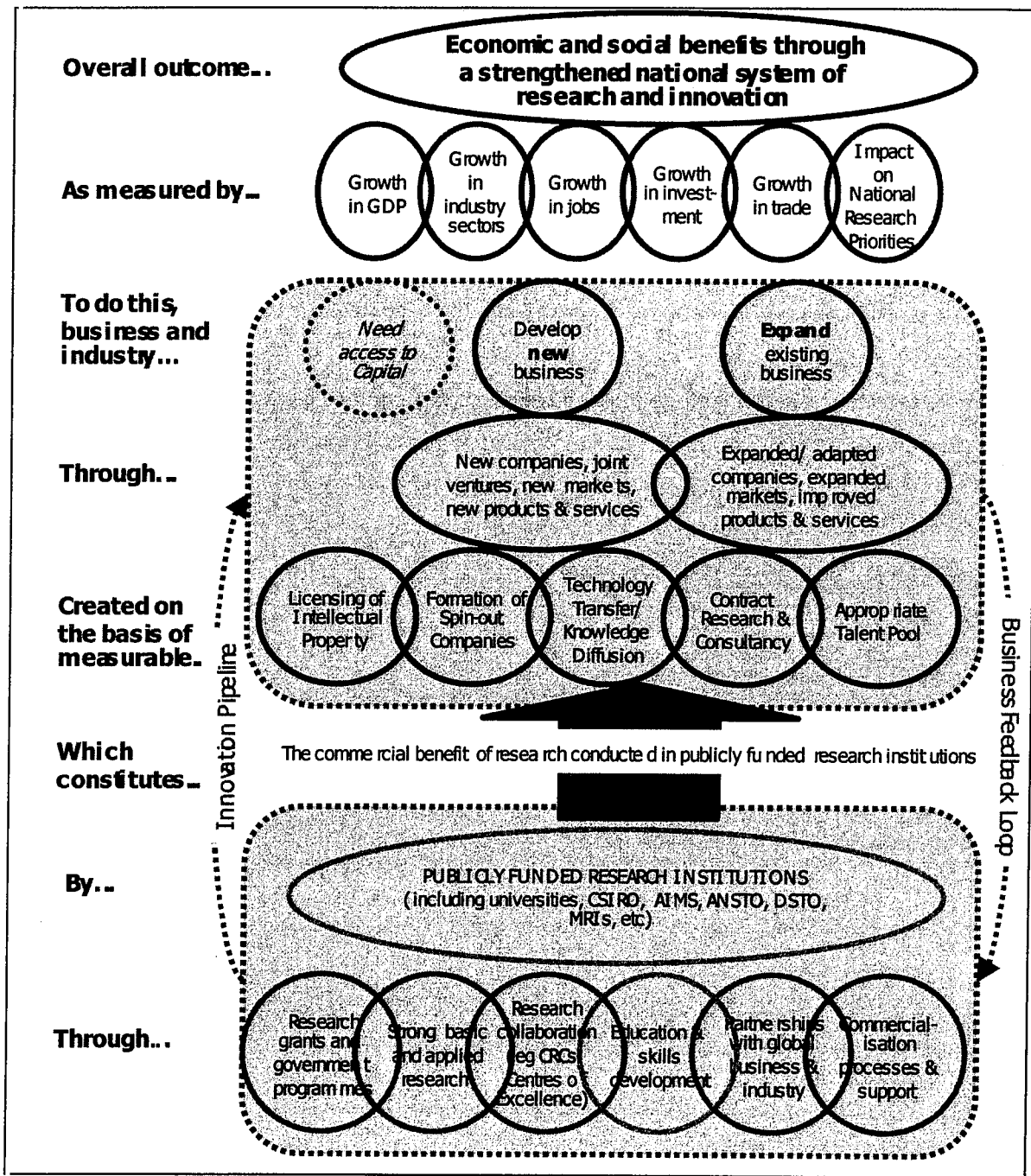
The map of publicly funded research commercialisation can also be read from the bottom up, whereby public sector research institutions are seen to provide research, skills, capabilities and research-related outputs that provide commercial benefit to business and industry. Such benefits include IP, spin-out companies, research consultancies, access to facilities, and the talent pool of both scientific and business professionals. These are deployed by industry to develop new business or expand existing business, thereby contributing to growth in GDP, jobs, etc to help deliver the overall desired outcome of economic and social benefits.

This map shows that there are many different ways that an idea or process can be taken to market. The challenge then is to develop a system of metrics that adequately reflects this dynamic and multifaceted system.

Developing a proposed system of research commercialisation metrics

Using the map of publicly funded research commercialisation as a general guide, and drawing on the metrics identified in submissions, the WG sought to develop a set of metrics for measuring and monitoring the performance of publicly funded research institutions in their efforts to contribute to the commercial success of Australian business and the wider community.

A matrix of metrics

Based on its analysis of metrics already in use in Australia and overseas, as well as those suggested in submissions, the WG arrived at a set of 40 potential metrics.[13] Reflecting its view that the existing definition of research commercialisation is too narrow, it classified these into three main groups, relating to:

1. Intellectual Property (identification, protection, transfer, exploitation)

2. Research Contracts and Consultancies

3. Skills Development and Transfer.

Within each group, it further classified the metrics in terms of whether they relate to inputs, processes, outputs, or outcomes.

Table 2 summarises the outcome of this analysis. The WG envisages that the metrics in Table 4 would meet the needs of Government for overall research performance information while also assisting individual institutions to monitor their commercialisation performance.

It is important to note that for the most part the metrics at Table 2 relate to the factors in the middle of the map of publicly funded research commercialisation (Figure 2 above)—i.e. measurable factors such as spin-out companies, licensing of IP, contracts and consultancies, and the development of an appropriate talent pool. This reflects a deliberate effort on the part of the WG to focus attention on those aspects of the system that are amenable to delivering metrics that meet the criteria outlined in the Introduction to this Report, i.e., metrics that are: specific; measurable; actionable; reliable; timely; cost effective (in terms of the cost of data collection); and efficacious (in terms of the activities they encourage).

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[13] The 40 do not include metrics relating to macroeconomic or broad social outcomes, which are identified in the last column of Table 2 as 'final outcomes'.

Table 2: Matrix of research commercialisation metrics

Main data groups	Supply side: Publicly Funded Research Sector		Demand side: Business & Community	
	Inputs/ Activities	Outputs/ Deliverables	Intermediate Outcomes	Final Outcomes
Intellectual Property (identification, protection, transfer, exploitation)	1. Patent Applications (including Plant Breeders Rights) & Patents Issued (No.) 2. Invention disclosures (No.) 3. Commercialisation Staff (No. & Costs) 4. Commercialisation Administration (Cost) 5. IP policies & practices (Documented & Applied)	6. Licences, Options, Assignments (No. & Value) 7. Royalty agreements (No. & Value) 8. Pilots/ Prototypes/ Clinical Trails (No.) 9. Client relations (No. of contacts/ interactions)	10. Gross revenue from licensed technology 11. New products, services or business processes 12. Start-ups/ Spin-outs (No., capitalisation & revenue) 13. Joint Ventures (No., capitalisation & revenue) 14. Initial Public Offerings (No., & capitalisation) 15. Venture capital deals (No. & value)	Changes in: • GDP • investment • employment • exports • health outcomes • environmental outcomes that can be reasonably linked to research commercialisation intermediate outcomes (using econometric analyses and studies).
Research Contracts & Consultancies	16. Research contracts (No. & Gross Revenue) 17. Consultancies (No. & Gross Revenue) 18. Joint Ventures (No. & Capitalisation) 19. ARC Linkage Projects (No. & Value) 20. Administration (Cost)	21. Reports (No.) 22. Publications (No. & type) 23. Conferences/ Seminars (No. & attendance) 24. Client relations (No. of contacts/ interactions) 25. standards & best practices	26. Business expenditure on R&D (BERD) in the public sector (Quantum & % of total BERD) 27. Repeat business (% of contracts with previous clients) 28. Flow-on business (No. of clients who become patent licensees and/or partners in JVs, spin-outs etc)	
Skills Development & Transfer	29. Commercialisation & entrepreneurial training for researchers (No. of courses offered, No. of graduates) 30. Scientific & research training for Industry (No. of courses offered, No. of graduates) 31. Course design - industry input & endorsement (No. of postgraduate courses with industry input to design and/or industry endorsement)	32. Research graduates employed in industry (No. & % of total cohort) 33. Industry funded postgraduate places 34. Staff exchanges (No. of Researchers to industry; industry to research sector) 35. Research student placements in industry (No.)	36. Industry sector satisfaction with quality of research graduates 37. New practices 38. New products/ services 39. Research postgraduate income 40. Research postgraduate Start-ups & Spin-outs	

However, 40 metrics is too many for ongoing monitoring of research commercialisation at a systemic level. For this reason the WG selected a 'core' group of metrics Table 3. The WG believes these ought to be applicable across all public sector research institutions, allowing comparisons and benchmarking.

Table 3 does not include metrics for 'final outcomes' or system- or economy-wide information such as Business expenditure on R&D (BERD) in the public sector (Quantum and % of total BERD). It is envisaged that this higher level data will continue to be collected through established and developing statistical processes, especially the surveys and data collection activities of the Australian Bureau of Statistics.

Table 3: Core group of metrics

Main data groups	Supply side: Publicly Funded Research Sector		Demand side: Business & Community
	Inputs/Activities	Outputs/ Deliverables	Intermediate Outcomes
Intellectual Property	1. Patent Applications (including Plant Breeders Rights) & Patents Issued (No.) 2. Commercialisation Staff & Administration (No. & Costs)	3. Licenses, Options, Royalty agreements, Assignments (No. & Value) 4. Pilots/ Prototypes/ Clinical Trials (No. & Value)	5. Gross revenue from licensed technology 6. New products, services or business processes created 7. Start-ups/ Spin-outs, Initial Public Offerings (No., capitalisation & revenue)
Research Contracts & Consultancies	8. Research contracts & Consultancies (No., Gross Revenue, Sectors & Company Size)	9. Peer-reviewed Publications & Reports (No. & type)	10. Repeat & flow-on business (% of contracts with previous clients)
Skills Development & Transfer	11. Commercialisation & entrepreneurial training for researchers (No. of courses offered, No. of graduates)	12. Research graduates employed in industry (No. & % of total graduates)	13. Research postgraduate income 14. Research postgraduates employed in Spin-outs

The WG has undertaken detailed analysis of the fourteen items in the core group of metrics, assessing them against the criteria outlined earlier in this Report. That analysis is provided at *Appendix 6: Assessment of the proposed core group of metrics.* Further development of the system of metrics could be carried out partly on the basis of this analysis.

Recommendation 2:

That the 14 metrics covering IP, contracts and consultancies, and skills development and transfer in Table 3 be adopted as the basis for future data collection and assessment relating to research commercialisation across Australia's publicly funded research institutions.

Data collection and future surveys of research commercialisation

Data collection

The data used in any metrics system needs to be reliable, timely and cost effective to collect. The existing NSRC is expensive both to conduct, report, and respond to. The NSRC for 2001 and 2002—including designing and conducting the survey, compiling the data, interpreting the data and publishing the results—cost in excess of $400,000 (excluding respondents' costs).

Some 700 copies of the NSRC Report for 2001 and 2002 were distributed to stakeholders. There was limited commentary in the press or in forums such as conferences and seminars. The NSRC data, however, has been useful in informing research and analysis within DEST and other Government departments. It has also been used by consultants engaged by DEST to research and advise on aspects of research commercialisation.

In addition, there are aspects of the NSRC which suggest that some of the data may not be as reliable as might be desired. For example, there are inconsistencies between the data reported on CRCs in the survey and data collected by the CRC programme. The latter indicate higher overall performance (sometimes double that of the survey), albeit from a somewhat higher number of CRCs than in the NSRC sample. The NSRC also understates the level of research expenditure by CRCs[14].

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[14] (2004) National Survey of Research Commercialisation Years 2001and 2002, p18, Report for the Department of Education, Science & Training, Canberra. Available at http://www.dest.gov.au/highered/commercialisation/nsrc.htm

CRC Programme data from 63 CRCs in 2001–02 show 17 spin-outs (versus 5 in the survey) and 107 licences (versus 48 in the survey). The NSRC for 2001 and 2002 was designed to prevent double counting of CRC data by universities participating in CRCs, and it is possible that this led to some confusion among respondents. However, this would not explain all of the differences between the two sets of data. It is also possible that CRC respondents to the NSRC found the process of responding to the survey costly and time consuming and were therefore less assiduous in gathering and reporting all the relevant information.

The CRC example points to the importance of balancing the benefits of surveys such as the NSRC with the cost of conducting them. Anecdotal feedback from survey respondents suggest that they value the NSRC data, but would welcome innovations to reduce the cost and time in responding. One way this could be realised is to draw on relevant data that is gathered on a regular basis by third parties—e.g. the Australian Bureau of Statistics, the Australian Tax Office, IP Australia, Australian Securities and Investments Commission, DEST's Science Group and Higher Education Group—and use that data in the analysis of research commercialisation activity and impact. It may be possible to discuss with such third parties the refinement and development of their data collection processes so that, over time, information relevant to research commercialisation can be gathered.

Data collection gaps

As noted in the section on 'Data gaps and deficiencies in the current approach' above, there is a need to ensure that future arrangements for the collection of data on research commercialisation are as streamlined as possible, with third party sources being used wherever possible and appropriate. As also noted in the assessment of the WG's proposed metrics, there are some areas where available data is limited or questionable. In these instances it will be necessary to set in place a process to improve the timeliness, availability and/or reliability of the relevant data.

This work should begin with the core group of metrics set out in Table 3 above, noting that most are reasonably robust in terms of data sources and integrity. The WG has provided some indicative assessments of the core group of metrics at *Appendix 5: Some specific approaches in Australia*. This work can be taken further in the process of refining and testing the proposed metrics.

Future surveys of research commercialisation

The NSRC now covers a time series of three years: 2000, 2001 and 2002. It is important that this time series data be continued in relation to the core group of IP related metrics identified in Table 5 above. These continue to be important for performance assessments and benchmarking, both domestically between institutions and sectors and internationally. However, one implication of the WG's proposed framework for metrics of research commercialisation is that some data collected in the first three years of the NSRC will not be collected in the future. For example, the WG does not believe that information relating to the employment of patent attorneys is sufficiently useful in policy or performance terms to warrant the cost of its collection. On the other hand, the WG's proposed framework also implies an extension of the scope and range of the metrics relating to research commercialisation, by covering research contracts and consultancies and skills development and transfer.

Recommendation 3:

Building on the metrics in Table 3, that a comprehensive data collection strategy for research commercialisation metrics be developed. The strategy should:

- maintain the existing time series data for the core indicators developed through the National Survey of Research Commercialisation

- address any deficiencies in data quality so as to improve data timeliness, availability and/or reliability (including those identified in this Report)

- wherever possible, draw upon existing and reliable third-party data to reduce the burden on respondents and to ensure consistency.

Issues for further study/development

This section identifies a number of issues that the WG consider require further examination and study as Australia's system of metrics for research commercialisation evolves. The WG has not made any specific recommendations in relation to these issues. The CCST may, however, wish to initiate further work in some or all these areas.

Trends towards more complex researcher–industry interactions

The relationship between Australia's research sector and businesses and industry is rapidly evolving. Interactions between the sectors are becoming broader, more sustained, and more complex. Industry and researchers interact through modes that extend well beyond the 'standard model', where the results of research (in the form of IP) are sold or licensed to business. The already reasonably strong mode of 'knowledge diffusion'—whereby research is brought to industry-wide adoption through communication, building capacity within industry through extension, education and training, and creating standards relating to production and distribution—is increasingly supplemented by the other emerging modes that Howard has identified: 'Knowledge relationships' and 'Knowledge engagement'. The former involves the use of 'know how' generated in the research process that is made available to industry through cooperation, collaboration, joint ventures and partnerships, while the latter is focused on long-term engagement centred on shared concerns and interests, especially through clustering and collocation of research facilities and businesses.

The recommendations that the WG has made seek to go some way to addressing these developments, especially in terms of research consultancies and contracts, access to specialist facilities, and skills development and transfer. However, there is a need for policy to pay greater attention to the less tangible and/or less direct modes of interaction, such as tacit knowledge interactions or the diffusion of knowledge through publications, personal interactions, professional and academic conferences and seminars, etc.

It is likely that both policy and practice will evolve to reflect these developments. It will therefore be important that Australia's system of research commercialisation metrics also be enhanced to reflect these developments and their potential impacts as business drivers for Australia's economy.

Policy and funding decisions and research commercialisation metrics

In some quarters there is an expectation that future funding and grant programmes will be driven in part by explicit measurements of the research sectors' performance in the commercialisation of research. To date, the collection and publication of research commercialisation data has been carried out without any direct connection or reference to funding arrangements for universities or other research institutions. While there are grants and programmes—mainly run by DITR—that

aim to promote and assist the commercialisation of some publicly funded research (e.g. Pre-Seed and potentially Commercial Ready), there is no commercialisation element in the major research funding programmes for universities or PFRAs.[15] Generally speaking, where research commercialisation is encouraged in the research sector—such as in the CRC Programme or aspects of the RDC Programme—there is no direct link between funding decisions and commercialisation performance per se.

The WG is aware that the potential connection between reporting on research commercialisation performance and funding is an issue that has arisen in wider debates, especially in relation to universities.

This potential connection is an important issue in its own right, but it also directly affects the design and deployment of a metrics system for research commercialisation. The behaviours and responses of researchers and research institutions are heavily influenced by whether or not a reporting regime is linked to funding. On the whole, there will be a greater tendency for 'gaming' or manipulation of results where there is (or could be) extra funding attached. On the other hand, where no money is attached, the incentive to change practices is diminished. These considerations directly influence the design and presentation of surveys and data.

It is therefore important that the current debate about research 'outreach' (or 'third stream' activities in the university sector) encompasses consideration of the role of commercialisation, how it interacts with other modes of interchange between researchers, industry and indeed the wider community, and whether and how future funding arrangements may or may not relate to commercialisation activity. The Research Accessibility Framework and especially the Research Quality Framework therefore need to be developed with an explicit understanding of the role and nature of research commercialisation as a means by which research and research outputs generate benefits for the community, are valued by the market, and accessed by industry.

National Principles of Intellectual Property Management

One of the main vehicles by which policy relating to research commercialisation is expressed and communicated to the research sector is through the 'National Principles of Intellectual Property Management for Publicly Funded Research'.[16] Given the evolving nature of research commercialisation and the increasingly sophisticated interactions between research institutions and industry, it is timely for the National Principles to be reviewed and revised to ensure that they reflect changes in policy and practice in the sector. This is relevant to the question of research commercialisation metrics because IP management drives much of the behaviour and activity that generates the information and performance that the commercialisation metrics system depends upon. Many government departments, agencies and other organisations were involved in the development of the National Principles and any discussions to change the National Principles would need to involve a wide range of stakeholders within government, the research sector and business.

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[15] However, it is noteworthy that research consultancies—which the WG has recommended be included in future metrics of research commercialisation—do count as part of the 'research income' component that drives 60 per cent of the Institutional Grants Scheme and 40 per cent of the Research Training Scheme.

[16] Published in 2001 by The Australian Research Council, The Australian Tertiary Institutions Commercial Companies Association, The Australian Vice-Chancellors' Committee, The Department of Education, Training and Youth Affairs, The Department of Industry, Science and Resources, IP Australia, The National Health and Medical Research Council. Available at: <http://www.arc.gov.au/pdf/01_01.pdf>.

Appendices

Appendix 1: Letter to stakeholders

Metrics of Commercialisation Working Group

Dear

I have recently accepted an invitation from the Australian Government to chair a Working Group on the metrics of commercialisation.

The Working Group is to consider ways of improving the measurement of commercialisation outcomes arising from publicly funded research. Our objective is to identify what future leading indicators will impact Australia's (and Australia's partners and competitors) economic, financial and social capital and I would greatly value your views on this issue. I've attached a simple template as a guide to outline the form and nature of information we are seeking to capture.

Our terms of reference and the membership of the Working Group are attached for your information. We are required to report in November 2004. The Working Group is being supported by a secretariat within the Department of Education, Science and Training (initial contact is Ms Sandy Stevenson, ph: 02 6240 9675, email: sandy.stevenson@dest.gov.au).

If your organisation would be interesting in contributing to this endeavour, I would be grateful if you could contact either the secretariat or myself (ph: 02 9717 3698, email: robert.muir@ANSTO.gov.au) by 10 August 2004. Written submissions will be due 31 August 2004.

In closing, I would stress that this endeavour is of key strategic significance and one of a number of inputs the Government is seeking in regard to its broader research and commercialisation dialogue.

Yours sincerely

Rob Muir
Chair
Metrics of Commercialisation Working Group
Director Business Development
Australian Nuclear Science and Technology Organisation

30 July 2004

To begin to address these issues, we are considering four groups of potential metrics:

Leading: likely future economic, social, and environmental benefits

Real time: current performance

Lagging: past performance

Learning: rate at which Australia is improving its performance.

Working Group on Metrics of Commercialisation

Mr Rob Muir (Chair), Director, Director of Business Development, ANSTO

Dr Evan Arthur, Acting Group Manager, Innovation and Research Systems Group, Department of Education, Science and Training

Ms Tricia Berman, General Manager, Innovation Policy Branch, Department of Industry, Tourism and Resources

Mr Simon Sedgley, Director, Policy and Planning, Australian Research Council

Mr Zack Herlick, General Manager, Australian Growth Partnerships, CSIRO

Ms Helen Fullgrabe, Principal Executive Officer, National Health and Medical Research Council

The Working Group has been established as part of the work of the Coordination Committee on Science and Technology (CCST). This Committee comprises representatives of Australian Government departments with science and technology interests, and of government research funding and research performing agencies. Established in 1989, the Committee brings together leaders of Australian Government departments and agencies with an interest and expertise in science and technology.

Terms of reference of the Working Group

i. Determine appropriate measurements / indicators to monitor economic benefit flowing from commercialisation of research funded by the public sector.

ii. Perform a stock take to identify work conducted in Australia and elsewhere to develop and apply metrics of commercialisation.

iii. Develop a priority list of data collection gaps that can be addressed by using resources available to CCST members.

Discussion of the Task

Today, technology is seen as the key to development and prosperity in most parts of the world.

Australian has some recognised strengths including in technology development, for example:

We are a technology player with more than 300 'world-first' and 'world- best' Australian technologies (the black box flight recorder, differential gears, bionic ears, gene shears, medical vaccines).

The 2003 Global Entrepreneurship Monitor (GEM) lists Australia as the world's 7th most entrepreneurial country, and 3rd in the developed world.

Well established academic sector. Highly educated, multilingual IT workforce. Medical science (biotech) is a global strength.

Fully deregulated telecommunications market with state-of-the-art equipment.

Australia's economy ranked 14th in the world, 4th Asia Pacific. CPI growth forecast amongst best in world.

To date, Australia has undertaken two National Surveys of Research Commercialisation using the Association of University Technology Managers methodology and Australian Bureau of Statistics innovation surveys in 1993-94, 1996-1997 and 2003. A recent report on the benefits of commercialisation -*The economic impact of the commercialisation of publicly funded R&D in Australia*—was prepared by the Allen Consulting Group.

The Australian surveys, in common with similar surveys overseas, measure commercialisation activity such as patenting, licensing and formation of spin-out companies. They do not measure the net economic value created, such as new industry sectors developed, new companies formed, new jobs created, jobs retained, and/or market share increases. And depending on the particular industry sector, such results may not be apparent for several years from the time of the actual transfer.

Thus, it is important to identify what future leading indicators will impact Australia's (and Australia's partners and competitors) economic and social well-being.

The inherent weaknesses of previous approaches include failing to measure the informal types of transfer that account for the majority of actual technology transfer and longer term economic benefit and are therefore more indicative of leading indicators:

Some of these types of activities are illustrated below:

People:

People movements to/from Australia in particular sectors and technology clusters including intercompany staff transfers,

Meaningful exchanges of information among global business and scientific colleagues,

Relationship building with global 'A' list educational, scientific, and business organisations,

Number of 'world-recognised' Australian scientific and business leaders.

Supply Side:

Learning and sharing best practice,

Growth in foundation science, engineering, and management talent both in numbers and new knowledge generation,

Creating and sustaining business- and tax-friendly environments which can exploit new knowledge for wider economic, social and environmental benefits,

Matching public investment in R&D and new knowledge creation with private sector and community perceptions of research sensitive needs, problems and opportunities,

Facilitating additional capital creation and formation,

Track record of increasing commercialisation successes.

Demand Side:

Developing new knowledge to sustain and improve the competitive position of Australian industry (solving current problems, deploying latest tools, creating new opportunities),

Provision of technical assistance and support to industry deploying new knowledge areas,

Training of skilled work force,

Accelerated routes to global markets to facilitate greater trade and investment opportunities,

Enhance the quality of life for future Australians by providing wider economic, social and environmental benefits.

Indicators Template

Metrics of Commercialisation

Indicator (leading, lagging, real time, learning, linkage)	Description	Rationale	Current source (if any)	Feasibility		
				Useful	Measurable	Cost Effective

Appendix 2: Submissions received

The following organisations provided submissions to the WG in response to the letter at Appendix 1.

Sub no#	Respondent
S1	NHMRC
S2	Edith Cowan University
S3	Flinders University
S4	Melbourne University
S5	IRD Board
S6	Business Council of Australia
S7	National Information and Communications Technology Australia
S8	CRC Committee
S9	Charles Darwin University
S10	Defence Science and Technology Organisation
S11	DITR
S12	Department of Finance and Administration
S13	Australian Institute of Commercialisation
S14	Department of Communications, Information Technology and the Arts
S15	Department of Agriculture, Fisheries and Forestry
S16	Griffith University
S17	University of Adelaide
S18	Central Queensland University
S19	Charles Sturt University
S20	University of Canberra
S21	Cooperative Research Centres Association
S22	CSIRO

A full analysis of the metrics suggested in submissions is available on the CCST website <http://www.dest.gov.au/science/ccst/>. This Appendix provides an overview of this work.

Initially, the WG identified four categories to organise and analyse proposed metrics in submissions. These were: *Leading*: likely future economic, social, and environmental benefits *Real time*: current performance *Lagging*: past performance *Learning*: rate at which Australia is improving its performance. Criteria were developed and supplied in a template form in the invitation for submission for respondents to use to organise their submissions (see Appendix 1 for details).

The same criteria were used by the WG to rate the suitability of metrics received in submissions were: 'description, rationale, current source of the proposed metric, usefulness, measurability and cost effectiveness'. The 'description & rationale' had to provide evidence of the suitability of the metric that it would provide useful information. The 'current source' factor allowed an element of discretion as to whether the metric would be robust and easy to source, for instance, Annual Reports. The last three factors were used to help rate the metric, i.e. whether it could be rated a 1st order metric (highly useful), a 2nd order metric (could be useful, needs more work), or not useful (discard). In addition, a number of submissions contained suggestions of current surveys that might be useful.

The table below summarises the results of the metrics received in submissions and a brief analysis of the main activity associated with that class of metric and the resulting rating of metrics in each metric class. As an overall observation, it was apparent to the WG that many of the metrics in the submissions were duplicates of or very similar to others. It was also apparent that the proposed metrics were (naturally) influenced by the specific circumstances of the organisation from whom the submission came.

Table: Metrics from submissions

Metric	No.	1st Order metric	No.	2nd Order metric	No.	Main activity associated with metric
Leading	39	1st order metric	25	2nd order metric	14	Research outputs (IP rights), contracts, funds raised, funding for skills development, fit for market analysis, interactions
Real time	18	1st order metric	12	2nd order metric	6	Funding, interactions, collaboration
Lagging	41	1st order metric	35	2nd order metric	6	Rate of return, trend data
Learning	17	1st order metric	9	2nd order metric	8	Interactions, training skills
Discarded metrics	12					
Suggested surveys	7					
Total metrics	134	1st order metric	81	2nd order metric	34	

Leading and *Lagging* indicators provided the highest number of suggested metrics in the initial grouping and 1st order metrics.

Leading metrics showed an overwhelming emphasis towards intellectual property rights, research outputs, quantum of investment funds, market analysis. These metrics have been the mainstay of reported research commercialisation metrics.

Lagging metrics provided the highest tally of all the metrics, both initially and 1st order, again, not surprising as the metric is predominantly concerned with time lag data—rates of return on investment and revenue streams, also trend data—success of spin-outs, number of entries on IP registers, turn-over, profits and value of contracts/consultancies.

Real time metrics gave early indications of a new grouping class—one that is more concerned with the researcher interaction end—scale of funding, collaborations and interactions.

Learning returned metrics dealing with training and gaining experience for researchers and business representatives in each others world, interactions—work experience sabbaticals, number of PhDs in industry, starting spin-outs etc.

The final tally for 1st order research commercialisation metrics was 81 metrics.

Appendix 3: Allen Consulting Report on *Measuring the impact of publicly funded research*

Table of suggested indicators from Allen Consulting Group (2005), *Measuring the impact of publicly funded research*, Report for the Department of Education, Science and Training, Canberra. Available at: <http://www.dest.gov.au/resqual/publications.htm>.

Suggested Indicators	Potential Diffusion Indicators for the Physical and Biological Sciences	Potential Diffusion Indicators for the Social Sciences and Humanities
Highly cited publications	Presentations given at industry sponsored conferences	Presentations given at learned societies
Patents	Presentations given at academic conferences	Presentations given at academic conferences
Highly cited patents	Presentations given at learned societies	Submissions made to government inquiries
Technology licensing revenue	Distribution of research newsletters to industry stakeholders	Citations of research in government policy publications
Employment in spin-off companies	Meetings attended with potential industry adopters of research	Citations of research in court judgements
Industry research contracts	Results from surveys of government and industry research managers as to who they regard as 'high-impact' academic researchers	Articles published in the popular press
Presentations to industry sponsored conferences	The number of research students that are subsequently employed within industry	Research cited in articles in the popular press
Presentations to industry and government knowledge users		Results from surveys of heads of policy sections in government departments as to who they regard as 'high impact' academic researchers
		The number of research students that are subsequently employed within government departments, Ministerial offices and industry.

Appendix 4: International trends and practices

Item 2 of the Term of Reference required the WG to *perform a stock take to identify work conducted in Australia and elsewhere to develop and apply metrics of commercialisation.*

In a highly competitive global environment policy makers are increasingly looking at methodologies to capture the performance of government funded research. In most countries this is generally done by counting narrowly defined research performance outputs which are manifested in activity measures such as patents, licences, start-up companies etc. Many countries have undertaken studies considering a broader range of indicators.

The United States

The AUTM survey (mentioned above) has been in operation for 11 years and focuses on indicators related to the generation of commercial outcomes. The survey provides a yearly profile of US universities, hospitals and research institutes and Canadian institutions. The data collected includes:

- number of FTE staff employed in technology transfer offices
- research expenditure
- legal expenditure and reimbursement
- patent related activity
- start-up activity
- licenses and options
- licence income.

The AUTM Survey does not capture contract research, skills development or research training.

Much of the debate surrounding the generation of commercial outputs (as understood by the standard linear definition of commercialisation) revolves around the ownership of IP. In the United States the Bayh–Dole Act of 1980 removed many impediments to university, government and industry collaboration by providing for universities and not-for-profit research institutes to retain ownership of IP resulting from government funded research; where universities have multiple sources of funding for research this allows for universities to retain ownership of IP. This has provided a clear framework for university, government and industry collaboration which has been credited with greatly increasing the commercial output of universities.

AUTM is currently examining ways to extend the coverage of their survey methodology to provide data more relevant to final outcomes and broader economic, social and environmental benefits of commercialised research.

The United Kingdom

The *Higher Education—Business Interaction Survey 2001-2002*[17] (HE-BI) presents comprehensive analysis of the extent and nature of collaboration between universities and business in the UK. The Survey employs a range of qualitative and quantitative measures to assess the level of commercial activity within universities, and the level of interaction with

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[17] Available at: <http://www.hefce.ac.uk/reachout/hebi/>.

business and the community. Many directly measure commercial output; some of the more qualitative measures provide useful information relating to the collaborative efforts of universities.

As well as the traditional measures related to patents, licenses, publications etc, some of the more interesting measures include:

- development and implementation of regional skills strategies through regional partnerships

- business representation on the governing boards of universities

- income from publicly funded collaboration research grants involving business co-funding or formal collaboration

- consulting activities and associated income

- spin-offs (number, staffing and turnover)

- research contracts entered into with businesses, including number, value, research field (including multi-disciplinary research) and industry segment

- monitoring of changes in labour market supply and demand and accounting for this in planning

- number of undergraduate placements in business

- provision of courses for business, number of students and total income

- support for national and regional economic development.

The Report warns against using the survey results as the basis for funding and suggests that another set of indicators—developed to reflect the demand side (business and community partners) of third stream funding—be developed to ensure that funding is directed towards achieving the desired commercial results

The Lambert Review of Business—University Collaboration (2003)[18] used data largely collected through the HE-BI survey and examined the level of collaboration between universities and businesses and recommended several ways in which the amount of collaboration can be improved. This included increasing and improving knowledge transfer between universities and businesses through increased third stream funding, and model contracts covering the ownership and exploitation of IP. One such model is that where public funding is involved, ownership of IP should go to the university (as is the case in the US under the Bayh-Dole Act). Business partners should be free to negotiate licence terms to access the IP.

In 2002, the Science and Technology Policy Research Unit (SPRU) at the University of Sussex published a report commissioned by the Russell Group of Universities (an association of 19 major research-intensive universities in the UK) titled *Measuring Third Stream Activities.*[19] The report examined the interaction between universities and society focused on commercial outcomes, including categories not normally picked up by traditional measures such as:

- advisory work

- commercialisation of facilities

- contract research

- staff flow

[18] Available at: <http://www.hm-treasury.gov.uk/media/EA556/lambert_review_final_450.pdf>.

[19] Available at: <http://www.clo.cam.ac.uk/documents/final_russell_report.pdf>.

- student placements

- learning activities

- curriculum alignment

- social networking

- non-academic dissemination.

The report concluded that indicators of university commercialisation activity are not sufficient to guide third stream policy and are a poor guide of the overall economic and social benefits of university activity. It also concluded that performance information on commercialisation is best focused at the level of activities and outputs, where relevant decisions and strategies are made.

In 2002 the *UK University Commercialisation Survey*[20] was conducted by Nottingham University Business School in collaboration with the University Companies Association and the Association for University Industry Links. The Survey gathered data on 125 UK universities and examined:

- the number of FTEs employed in commercialisation activities, licensing activities and spinout company development

- invention disclosures and patents

- IP protection expenditure

- licensing activity and the destination of licenses, i.e., licenses that went to new spin-out companies, SMEs, large companies and other institutions (this included a further breakdown to show where the licence had gone to a UK or non-UK based business)

- licensing income and the number of licenses yielding income, income from licenses generating royalties, number of licenses yielding income related to sales revenue

- revenue from assignment of patents

- proportion of revenue paid to the inventor, department and institution

- spin-out company activity (number generated and number externally financed, further broken down by source of funds) and the number and value of exits from spinout companies

- factors that impeded or supported commercialisation activities and international comparisons.

Canada

The Canadian Foundation for Innovation is an independent corporation created by the government of Canada to fund research infrastructure. In March of 2004 the Foundation released its *Commercialisation Report*[21] encompassing the commercial activities of 113 universities, hospitals and colleges within Canada. The report uses many of the measures captured in the AUTM Survey but includes additional fields:

- revenue from royalties and liquidated equity

- material transfer agreements

- collaborative and partnership activities.

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[20] Wright, M., Binks, M, Vohora, A and Lockett, A., (2003) *UK University Commercialisation Survey: Financial Year 2002*, Nottingham University Business School.

[21] Available at: <http://www.innovation.ca/publications/2004/2004_comm_e.pdf>.

New Zealand

The Foundation for Research Science and Technology *Outcome Indicators*[22] report for 2003–04 collected data from all research providers who receive funding from Foundation research programmes. The data consisted of:

- new or improved products, processes and services for users

- number of products, processes and services per million dollars invested

- number of products, processes and services for users per million dollars invested

- this collects information grouped on the end beneficiary of the output

- What was delivered (product, process or service) and how did New Zealand benefit (this consists of 10 categories grouped under three headings: More competitive New Zealand businesses, increased understanding and knowledge, and improved environment and social conditions)

- third party revenue

- all IP generated by type (plant variety rights, copyright, trademark, PCT applications and provisional patents) and per million dollars invested

- number of user reports per million invested and distribution of these reports within specific user groups and categories

- number of journal articles, books (including chapters, theses, peer reviewed conference proceedings), keynote presentations and awards

- number of peer reviewed publications and presentations per million dollars invested

- number of relationships between researchers and other parties per million invested

- distribution of relationships between users and researchers.

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[22] Available at: <http://www.frst.govt.nz/Evaluation/ProviderIndicators.cfm>.

Appendix 5: Some specific approaches in Australia

The following sections briefly outline current specific approaches to research commercialisation performance metrics and the issues they raise.

Cooperative Research Centres

The CRC programme emphasises collaborative arrangements to maximise the benefits of research through a process of utilisation, commercialisation and technology transfer. It has a strong education component with a focus on producing graduates with skills relevant to industry needs.

Within the four selection criteria used to assess applications for CRC funding, criteria 1 and 2 are given the greatest weighting:

1. The outcome will contribute substantially to Australia's industrial, commercial and economic growth

2. The path to adoption (commercialisation/utilisation) will achieve the identified outcomes

3. The collaboration has the capability to achieve the intended results

4. The funding sought will generate a return and represents good value for the taxpayer.

Each CRC is required to develop an evaluation strategy which identifies objectives and milestones or targets, and the performance indicators used to measure progress towards them. CRCs also complete an annual Management Data Questionnaire (MDQ) which is used for assessment of the performance of the CRC Programme as a whole, rather than individual CRCs.

The MDQ collects, inter alia, data on:

- patents maintained and filed, both in Australia and overseas

- the number and value of research contracts

- the number of and income from, spin-off companies and technology commercialisation agreements

- student employment destinations

- the number of publications and reports for industry and other end users

- the number of formal research related publications

- the number of doctoral research students and masters research students

- the number of staff members supervising research postgraduate students

- the extent of research collaboration with industry and business both within Australia and internationally

- the number of and value of Commonwealth grants received

- the number of undergraduate education courses conducted.

In its submission to the WG, the CRC Committee advised that there is currently some overlap between the MDQ and Annual Reports and that this will be removed once CRC reporting goes online.

Publicly Funded Research Agencies

Australia's three main publicly funded research agencies (PFRAs)—CSIRO, ANSTO and AIMS—all have a similar 'standard suite' of performance indicators.

The main difference between the PFRAs and the AUTM methodology is that the former include information on contract research and data from client response surveys. All the PFRAs rely heavily on their ability to attract client-based contract or consultancy research that is paid for by industry. So the inclusion of not just the number, dollar value and type of contract or consultancy, but also the industry perceived 'value' of the work is of critical importance as an indicator. Like the CRCs, some of the PFRAs employ an indicator to rate the level of involvement and development of skills in their organisations.

CSIRO has published a report (closely following the AUTM methodology) that summarises its research commercialisation efforts for the period 2001–02.[23] Collecting this suite of data allows for comparisons to be made between CSIRO and similar institutions in the USA and Canada. Unlike the AUTM reports, the CSIRO report includes data on contract research activity.

Australian rural Research and Development Corporations

The RDC model is a unique partnership between the Australian Government and a mix of private, industry-owned companies and statutory corporations working within the public sector. RDCs operate primarily through a diffusion model, seeking the fastest and most effective means of generating research outputs, findings and insights into their field.

The NSRC does not currently include the RDCs. However, as the RDCs commission research (as opposed to conducting it themselves) it is probable that some of the reporting in the NSRC includes the commercialisation activities of research commissioned by the RDCs.

Due to competing interests within the RDC model itself, RDCs have developed guiding principles for the management of IP which include, but is not limited to, the standard commercialisation route. The guiding principles focus on pursuing the most effective route to ensuring adoption of a new technology or practice, rather than generating a more conventional commercial outcome.

RDCs are legally accountable for performance and compliance reporting. This information is published in an annual compendium, *Innovating Rural Australia: Research and Development Corporation Outcomes*. In the following table are indicators used to measure success of RDCs efforts against adoption indicators.

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[23] *CSIRO Research Commercialisation Report for 2001–2002*, (2003), available at: <csiro.gov.au/proprietaryDocuments/CSIROcommreport2003.pdf>.

Table: Adoption indicators commonly used by RDCs

Indicator type	Description	Rationale	Current Source
Demand - real time	Education and training of producer groups in utilising new R&D outputs—being new practices or the use of new product	Training of skilled workforce, usually to derive an economic or environmental benefit	Attendance records, follow-up surveys
Both Supply and Demand - leading	Input to drafting and acceptance of new product standards or policy	Establishing best practice, also accelerating routes to global markets	Acceptance and implementation of standards, measures of volume and value
Demand - lagging	Rates of return on selections of completed projects	Enhanced economic and social benefits	Cost/benefit analysis
People - leading	Investment in General Business Training for Women and Young People	Number of recognised business leaders	Attendance records, surveys, career analysis
Supply - leading	Commercialisation and promotion of a new animal or plant variety or processed product	Commercialisation successes	Sales targets—either volume or value
Demand - real time	Introduction of extension tools	Technical assistance to industry deploying new ideas	Attendance records, follow-up surveys
Supply - leading	Use of broad-based education campaigns	Learning and sharing best practice	Materials produced and distributed
Demand - real time	Increases in production output or cost savings due to adoption of an R&D output, as measured by volume or value	Enhanced economic benefits	Measures of volume or value

Source: Department of Agriculture, Fisheries and Forestry submission the CCST Working Group on the Metric of Commercialisation 2004.

The Australian Research Council

The ARC[24] collects data on the performance of research funded under the National Competitive Grants Program (NCGP).

The key performance indicators identified for the NCGP include: research awards data, outputs and outcomes of research projects funded under the program, and independent studies of various research performance measures (conducted periodically). While the research awards data and outputs and outcomes are available on an ongoing basis (allowing regular reporting), the independent studies are conducted periodically.

Successful grant applicants are required to provide a progress report to the ARC annually and a final report on completion of their research project (within six months of completing the research). A range of data is available for extraction from the final reports including:

- descriptions of research outcomes and commercial and other benefits to partner organisations, including firms

- project outputs (including publications as well as measures of commercialisation activities such as patents, licences and start-up companies)

- numbers of research personnel involved in a research project (including, for example, Australian and overseas postgraduates and early career researchers).

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[24] The information on ARC is an extract from the ARC Annual Report 2003-2004 (2004), available at: <http://www.arc.gov.au/publications/annual_report.htm>.

In 2003, the Allen Consulting Group presented its report *A Wealth of Knowledge—the Return on Investment in ARC-Funded Research*,[25] a detailed econometric analysis of the benefits flowing from ARC funded research.

The report performed two distinct forms of economic analysis. The first utilised a 'top-down' approach analysing the drivers of productivity growth. The second, the 'bottom-up' approach determined the level of benefit realised from ARC funded research using a case-study method.

The top-down approach determined the difference between the output growth of the Australian economy and the growth in inputs of the capital and labour markets. This difference was used as an indicator of technological progress. The contribution made to this technological progress by ARC funded activities was then estimated and used to determine the economic return on ARC funded research.

The bottom-up approach determined the contribution of specific areas benefiting from ARC funded research to technological progress. This was modelled through the Centre of Policy Studies at Monash University's general equilibrium model of the Australian economy. An estimate of the overall benefit to particular social and economic areas could be identified as well as the overall benefit to GDP.

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[25] Allen Consulting Group, (2003), *A Wealth on Knowledge—The Return on Investment from ARC-Funded Research*. Available at: <http://www.arc.gov.au/pdf/ARC_wealth_of_knowledge.pdf>.

Appendix 6: Assessment of the proposed core group of metrics

[See Table 3: Core group of metrics, page 17]

Main data groups	Description	Source	Specific, Measurable, Actionable, Reliable, Timely	Cost Effective	Efficacious (Behaviours)	Comment
INTELLECTUAL PROPERTY						
1. Patent Applications (including Plant Breeders Rights) & Patents Issued (No.)	Input/activity measure of patents activity	?IP Australia; ?USPO; ?other	Yes. Provides an early indication of inputs to the innovation 'pipeline'. Reliability and timeliness depend on accessibility and quality of patent offices' databases.	Yes (assuming can source from patents offices)	Risk 'vanity patenting' if not counterbalanced by other factors/indicators and type of patenting - deliberately holding up access to know how.	Import base-line information, but need to be careful interpreting the data.
2. Commercialisation Staff & Administration (No. & Cost)	Input/activity measure of commercialisation effort. No of staff (FTE) and wages; Cost of administering commercialisation processes	Research institutions (survey)	Yes, assuming research institutions' records are accurate and up to date.	Survey would have to be well designed and useful to the sector.	Need to ensure there are not any implicit or explicit financial rewards for increasing admin costs.	Useful in assessing efficiency of organisations/sector in delivering IP outputs.
3. Licenses, Options, Assignments and Royalty Agreements (No. & Value)	Output measure of value of IP	Research institutions (survey)	Yes, assuming research institutions' records are accurate and up to date.	Survey would have to be well designed and useful to the sector.	Important to stress importance of $ value, not simply No. of LOAs, to encourage focus on value/impact.	Important information for benchmarking and monitoring value of IP to organisations/sector.
4. Pilots/Prototypes/Clinical Trials (No. & Value)	Output measure of IP moving to proof of concept	Research institutions (survey)	Yes, assuming research institutions' records are accurate and up to date. May need to develop data specification, as this is an area where there is considerable variability in practice.	Survey would have to be well designed and useful to the sector.	Encourages researchers to take ideas/inventions to the prototype phase, which is an important link to commercialisation.	Need to develop data specification and test with sector.
5. Gross revenue from licensed technology; (IP related revenue and licensed/assigned technology revenue)	Intermediate outcome measure of sales of technology based on licensed IP. Calculated by multiplying license revenue by royalty rate.	Research institutions (survey)	Yes, assuming research institutions' records are accurate and up to date.	Survey would have to be well designed and useful to the sector.	Focuses attention on the market value of IP in terms of gross sales of relevant technology/innovations.	Important indicator of impact of IP in the broader market.
6. New products, services or business processes created	Intermediate outcome measure of market innovation from IP	Research institutions (survey)	Yes, assuming research institutions' records are accurate and up to date. May need to develop data specification, as this is an area where there is considerable variability in practice.	Survey would have to be well designed and useful to the sector.	Emphasises importance of innovative impact of IP/ideas/research.	Need to develop data specification and test with sector.
7. Start-ups/ Spin-outs, Initial Public Offerings (No., capitalisation & revenue)	Intermediate outcome measure of business value generated from IP	Research institutions (survey)	Yes, assuming research institutions' records are accurate and up to date.	Survey would have to be well designed and useful to the sector.	Emphasises importance of business impact of IP/ideas/research. Some risk of encouraging spin-outs for their own sake.	Important outcome information, but need to take care not to encourage spin-outs for their own sake.

Main data groups	Description	Source	Specific, Measurable, Actionable, Reliable, Timely	Cost Effective	Efficacious (Behaviours)	Comment
CONTRACTS & CONSULTANCIES						
8. Research contracts & consultancies (No., gross revenue, sectors & company size)	Input/activity measure of research-based contract services and income	Research institutions (survey)	Yes, assuming research institutions' records are accurate and up to date. May need to develop data specification, as this is an area where there is some variability in practice.	Survey would have to be well designed and useful to the sector.	Recognises the significance of the role of 'know how' in the researcher-industry interrelationship.	Need to develop data specification and test with sector.
9. Peer reviewed Reports and Publications	Output measure of deliverables generated through research-based contract services	Research institutions (survey)	Yes, assuming research institutions' records are accurate and up to date. May need to develop data specification, as this is information is not generally collected as a subset of research constancies & contracts.	Survey would have to be well designed and useful to the sector.	Would need to ensure this did not risk increasing the quantity of publication to generate positive numbers.	Need to develop data specification and test with sector.
10. Repeat & flow-on business (% of contracts with previous clients)	Intermediate outcome measure of market value placed on research based contract services	Research institutions (survey)	Yes, assuming research institutions' records are accurate and up to date. May need to develop data specification, as this is an area where data specification and collection is underdeveloped.	Survey would have to be well designed and useful to the sector.	Encourages focus on growing longer-term relationships between researchers and business.	Need to develop data specification and test with sector.
SKILLS DEVELOPMENT & TRANSFER						
11. Commercialisation & entrepreneurial training for researchers (No. of courses offered, No. of graduates)	Input/activity measure of commercialisation skills development among researchers	Survey of courses and institutions' annual reporting	Yes, assuming reporting cycles are timely and provide sufficient detail.	Would draw on existing reporting and public information.	Would need to guard against encouraging the creation or rebadging of courses for the sake of driving the data. Need to have an industry 'value' or commitment to the courses either endorsement or enrolment.	Could become a useful time series to track the integration of commercialisation training in research training.
12. Research graduates employed in industry (No. & % of total graduates)	Output measure of research skills development for industry	Postgraduate destination survey; ABS Census data	Some lag in data, especially ABS census data. Would need to take care to not over-analyse, as a postgraduate may be employed for reasons entirely separate from the postgraduate training. Still important longer term impact information.	Would draw on existing reporting and public information.	Unlikely to skew behaviours in research sector or industry, as collection is at high level of aggregation.	Could become a useful time series to track the supply of research graduates to industry.
13. Research postgraduate income	Intermediate outcome measure of market value of research degrees/ training	Postgraduate destination survey; ABS Census data	Some lag in data, especially ABS census data. Would need to take care to not over-analyse, as a postgraduate may be employed for reasons entirely separate from the postgraduate training. Still important longer term impact information.	Would draw on existing reporting and public information.	Unlikely to skew behaviours in research sector or industry, as collection is at high level of aggregation.	Could become a useful time series to track the value research graduate training.
14. Research postgraduates employed in spin-outs	Intermediate outcome measure of linkage between company formation and research training	Research institutions (survey)	Yes, assuming research institutions' records are accurate and up to date. May need to develop data specification, as this is an area where data specification and collection is underdeveloped.	Survey would have to be well designed and useful to the sector.	Could risk encouraging spin-outs to employ people for the sake of increasing their postgraduate numbers, not for their skills/training/	A useful indicator of the integration between the research training system and the spin-out/start-up aspects of the innovation system.

Trade & Investment

Critical Issue: Sector variations in global business practices, timelines and cultures

Commercial Imperatives

Government Research Priorities: Economic, Health, Defence, Environment, Societal

Business Environment

Commerce

Market Economy
Successful Partnerships

Corporate Funding

Supply Environment

Critical Issue: Commercial Advice on Boards
Critical Issue: Culture Change
Critical Issue: Government Liaison Functions

Public Funded Research Agencies

Beyond Metrics

4/12/2005 - v7

Global Market Opportunities

Critical Issue: Market Knowledge

Critical Issue: Market Introductions

Critical Issue: Regulatory & Legal Environment

Critical Issue: Track Record

Pipeline

Critical Issue: Symbiosis

Demand Environment

Critical Issue: Management
Critical Issue: Access to Capital
Critical Issue: Investment & Tax Incentives
Critical Issue: Corporate Growth & Exits

Enterprise

Business Expansion SMEs

Emerging Ventures

Government Incentives, Market Pull

Angel Capital Investment

Early Stage Venture Capital

Robert Muir
Prometheus Equity Partners
April 12 '05