Submission to Review of the National Innovation System

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Declaration of Interest: The author is a former senior researcher in the Smart Internet Technology Cooperative Research Centre (SITCRC). The views expressed in this submission are the author's alone and are not those of Swinburne University of Technology, the SITCRC, or respective institutional partners and staff. Due to the author's experience, this submission focuses on the CRC system, particularly strategic implementation issues. Its suggestions may be applied more broadly to capability building for a national innovation system.

1. Challenges to the Cooperative Research Centres (CRCs) System

The Hawke Government introduced the Cooperative Research Centres (CRCs) in 1990 as an institutional initiative to leverage innovation and research and development (R&D) synergies (www.crc.gov.au). To my understanding the CRCs initiative had several "fundamental premises" that shaped its institutional design: (1) a government policy context of transition in 1990 from neo-Keynesian intervention to market-based management; (2) an R&D innovation model based primarily on sectoral and industry clusters; and (3) knowledge transfer between Australian universities and relevant partners from sectoral, industry, government and small & medium enterprises.

Are these "fundamental premises" still valid for the contemporary and near-future strategic environment? Challenges include: (1) the complex dynamics and volatility of markets which affect institutional design and portfolio management (Hughes 2000); (2) the evolution of global foresight, managerial frameworks and strategic thinking in a likely "multi-polar" geopolitical environment; (3) the emergence of new innovation models and their assimilation with existing models at a more conceptual/integral level (Moore 2005) including enterprise level strategy (Ross, Weill & Robertson, 2006); (4) the high costs of existing models compared to "disruptive" challengers that include black markets, commercial R&D firms, international clusters, and open source software; and (5) "wicked problems" notably black markets, climate change and new security threats.

Cooperative Research Centres represent a special "instance" of R&D innovation due to the complexities of strategic implementation in a multi-stakeholder strategic alliance (Ellyard 1998; Morgan, Levitt & Malek 2007). The "institutional design" issues detailed below also arise in parallel debates about risk management in "tightly coupled" technological systems (Perrow 1999), global regulation and "irrational exuberance" in hedge funds and financial markets (Bookstaber 2007), and in post-September 11 post-mortems about the design, purpose and organisational sociology of United States intelligence agencies (Zegart 2007). Awareness of these parallel debates – and the solutions now being implemented – might contribute to capability building for a national innovation system.

2. The Critical Role of Universities and Research Culture

Australian universities contribute significantly to the major infrastructure and talent pool for CRCs. In doing so, universities interact with a range of multi-agent stakeholders and must transform into dynamic institutions (Wheatley 1992). "Research culture"—norms of academic scholarship, team collaboration, discipline knowledge and participation in colloquia, journals and other peer review mechanisms—is one way for this to occur.

For example, Columbia University professor Emanuel Derman (www.ederman.com) had negative experiences as an "early career" research at Bell Laboratories due to poor research management. However, a more vibrant "research culture" at the investment bank Goldman Sachs—a culture that valued academic rigour, business acumen and conceptual skills—provided a more satisfying experience and enabled Derman to build a long-term research career as a boundary-spanner between industry and university stakeholders (Derman 2004).

Innovation advocates often point to information technology companies such as Google and Sun as exemplars of the pivotal role that universities play in new venture creation and industry/sectoral development (Vise 2005; Ignatius 2006; Vise & Malseed 2006; Hamel 2007). However, post-mortems on these exemplars reveal some overlooked details on overcoming the barriers to innovation and strategic implementation: (1) the critical role of Stanford University's Office of Technology Licensing (http://otl.stanford.edu) for intellectual property and the US Patent & Trademark Office for patent protection (www.uspto.gov); (2) Stanford's proximity to Sandhill Road venture capital firms for seed funding; and (3) the importance of process maturity in rapid development, market intelligence, commercialisation pathways and post-acquisition integration for competitive growth.

Two Australian companies where university research was "catalytic" and that followed the above process for new venture creation are Austhink (www.austhink.com) which has University of Melbourne links, and Leximancer (www.leximancer.com) which has Queensland University links. Both firms provide software tools for decision support, data mining and intelligence augmentation. Ironically, both companies have achieved international success and venture capital funding through market-based management instead of the CRC partner route. Two further approaches to innovation that could be adapted are Newcastle's This Is Not Art festival (www.thisisnotart.org) that has community resilience, rapid prototyping and social network dimensions, and X Media Lab's mentor network (www.xmedialab.com).

The emergence of financial engineering as a new sub-discipline in corporate finance illustrates a second approach: the "co-evolution" of new industry sectors, markets and universities. Cold War era science and technology projects created the demand in the 1960s and early 1970s for a cohort of mathematicians and physicists. However, by the mid-1980s a geopolitical climate of detente and a decline in S&T projects meant that many people in this cohort left government research laboratories and universities. Wall Street investment banks and hedge funds provided the catalyst, where these researchers were able to adapt their domain expertise to build financial models for derivatives, options and futures trading. By the late 1990s these researchers had developed enough industry credibility to create and fund new departments at major universities in the United States. In a move that saw some practitioners come full circle, they left Wall Street to oversee these new teaching and research programs (Lindsey & Schachter 2007; Mehrling 2005; Derman 2004).

Collectively, these approaches suggest that universities will continue to have a pivotal role in knowledge generation and transfer—however, possibly a different role to that envisioned in the "fundamental premises" mentioned above.

3. Strategic Implementation Opportunities

The next section briefly discusses some strategic implementation opportunities in corporate governance, portfolio and strategic human resources management.

3.1 Corporate Governance

Corporate governance has a multi-dimensional role in CRCs, from board selection and institutional alignments at portfolio and program levels to research audits and practitioner ethics (Schwartz & Gibbs 1999). Cautionary examples of corporate governance "failure" and "moral hazard" include NASA's 1986 launch decision for the "Challenger" space shuttle, the 1998 collapse of the hedge fund Long-Term Capital Management, the 2001 bankruptcy of Enron Corporation, and the 2006 closure of AOL Research after the public release of customer identities in search engine records.

The following are possible "improvement opportunities" for CRC corporate governance:

3.1.1. CRC funding applications involve significant "sunk" and "transaction" costs for the parties involved, particularly if proposals are not successful, or if strategic coalitions fall apart during the negotiations about the "hurdle" requirement for "matching grants". A more "lightweight" screening process that still has rigorous risk management (Damodaran 2008) and is aware of the complexities of multi-party negotiations and strategic alliances might address this problem. One unintended side effect of CRCs in year five is that this forces CRC management to develop a bid and undergo several reviews that may create "strategic drift" from the existing CRC's day-to-day operations.

3.1.2. CRCs and other institutions could achieve greater transparency and visibility through market-based mechanisms. Potential models include: **(1)** "social network analysis" maps of CRC board members, their institutional affiliations and expertise, perhaps as a "crowdsourcing" or "citizen journalist" project modelled on Wikipedia (www.wikipedia.org); **(2)** governance measures in institutional reporting such as Audit Integrity (www.auditintegrity.com), Transparency International (www.transparency.org) or intermediaries like Standard & Poor's (www.standardandpoors.com) and Moody's (www.moodys) in capital markets; **(3)** more dynamic strategic communication that is

accessible to the public; (4) “co-creation” and “peri-style” involvement of the public in the ideation, vision and synthesis stages of R&D innovation (Prahalad & Ramaswamy 2004); and **(5)** verification mechanisms for “in kind” contributions by all stakeholders and to prevent or minimise “free riding”, “market for lemons” and “vapourware” scenarios that can arise due to multi-stakeholder coordination problems and information asymmetries.

3.1.3. Greater exploration of the opportunities for inter-CRC collaboration and coordination, notably for cross-sectoral knowledge transfer. This could minimise the potential duplication of research projects within industry CRCs that can operate as silos, and that may be working on similar projects with different CRC partners. Furthermore, it might enable the “Team A”/“Team B” approach as exemplified by Craig Venter’s Celera Genomics (www.celera.com) and the Ansari X-Prize Foundation (www.xprize.org), which respectively used market-based management to accelerate the innovation agenda in human genomics and space commercialisation.

3.1.4. Research audits might be improved through a peer review process of “comparative randomised sampling” of CRC project scope documents and final deliverables. This would provide a quality management check on research management processes. It would also reduce the potential to skew findings by “gaming” the auditors, such as internal pre-selection of external experts for review boards. Alternatively, an existing body such as the Australian Universities Quality Agency (www.auqa.edu.au) or the Institute of Internal Auditors Australia (www.iia.org.au) could provide this function.

3.2 Innovation Management

CRCs currently undertake portfolio and project management activities generally in a "matrix" organisational structure, based on sector/industry targeted portfolios and projects. Generally, this is coordinated between: (1) a CRC head office that has corporate strategy and portfolio management responsibilities at an enterprise level; (2) university partners that have administrative and R&D responsibilities at program and project levels; and (3) CRC partners who provide expertise and resources at enterprise, program and project levels.

The following are possible "improvement opportunities" for CRC innovation management:

3.2.1. Cascade the R&D management insights of process and quality management experts into CRC innovation systems, structures, processes and workflows. Relevant experts include W. Edwards Deming and Joseph Juran in quality, Toyota's "kaizen" or "lean" approach to concurrent engineering and workflow, and the "agile" movement in software engineering (Augustine 2005), notably the trans-disciplinary approach to work practices (Beck & Andreas 2004; Cockburn 2006) and collaboration in ad hoc groups (DuPree 1993). Rather than advocate this as a "silver bullet" solution (Brooks 1987), the aim here is to disseminate best practices and processes, and to enhance the "interface" between CRC stakeholders. For example, 3M experienced significant pushback from researchers during a Six Sigma implementation, highlighting that even proven methodologies must be adapted to organisational cultures, processes and work practices (Hindo 2007).

3.2.2. Transforming the portfolio and project management frameworks to remove "legacy" issues, "heavyweight" processes and administrative burdens. Improvement opportunities include: **(1)** mature processes for "business case" development at the start of research projects, and "project gate" reviews at regular stages; **(2)** attention to scope, staged delivery, clarification of fuzzy goals and ways to reduce "muda" or waste; **(3)** evaluation, closure and post-mortem processes such as the US Army's "post-implementation review" in the US Center for Army Lessons Learned (http://call.army.mil/); **(4)** "glance management" tools that cut the administrative burden such as information dashboards, standardised forms, "benefits realisation" summaries and "lead"/"lag" indicators (Davenport 2007); and **(5)** benchmark the decision-making processes of mergers and acquisitions firms such as Blackstone and Kolhberg Kravis & Roberts as potential best practices.

3.2.3. Apply "real options" pricing from capital budgeting (Kodukula & Papudescu, 2006; Damodaran 2008) to portfolio management and throughout the research project lifecycle, to maximise the realisable benefits for all stakeholders. One side effect of this would be to establish a "time decay" valuation similar to financial derivatives and options for the benefits and risk-returns of research deliverables, products and prototypes. This could provide an alternative valuation methodology to evaluate the market benefits of research, and to distinguish between research categories (basic, applied, blue sky and blended) and types of deliverables (analytic, descriptive, and formative).

3.2.4. Explore different instruments for "interface" management between multi-party stakeholders: **(1)** spin-off consultancies or involve industry stakeholders with researchers at the ideation phase to overcome the "two cultures" problem that can arise between academic publication and commercialisation (Snow 1964); **(2)** inter-CRC collaboration and coordination; **(3)** multi-stakeholder consultation hubs; and **(4)** other mechanisms such as prediction markets.

3.3 Strategic Human Resource Management

The following are possible "improvement opportunities" for CRC strategic HR management:

3.3.1. Develop more flexible hiring practices and career pathways for CRC researchers. This could include: **(1)** "transition in" and "transition out" processes for new staff (Watkins 2003); **(2)** hiring on a project-by-project basis and opening up the potential talent pool to broader stakeholders such as university student teams, industry people and the public; **(3)** a targeted focus on consulting, entrepreneurship, group and leadership development, and knowledge/relationship management skills required for commercialisation and dealing with CRC partners (Block 2000; Dawson 2005; Maister 2000); **(4)** to develop a "body of knowledge" approach that "chunks" domain expertise into a career pathway where insights can be re-used on projects and communicated to non-specialists (McConnell 2003); and **(5)** have risk mitigation strategies to prevent "death march" projects which are high-profile yet under-resources and politicised, and which can trigger team break-ups (Kidder 1981; Yourdon 2003).

3.3.2. Develop a set of "human capital" and "talentship" measures to support an evidence-based approach to research management and deliverables output (Boudreau & Ramstad 2007; Huselid, Becker, Beatty 2005). This may be framed as part of a broad approach to inter-generational knowledge transfer and new management development in CRC staff (Cecil & Rothwell 2006). It could be aligned with R&D innovation measures (Branscomb & Keller, 1999; Davila, Epstein & Shelton, 2005) that would help to dispel the popular "myths" of how innovation occurs (Berkun 2007). The measures would be primarily for strategic HR management and project decision-making rather than as an addition to the proposed Excellence in Research for Australia, which any measures could be harmonised with.

3.3.3. Leverage models such as MIT's OpenCourseWare project (http://ocw.mit.edu) and Apple's iTunes U (www.apple.com/itunesu) to provide a more scalable solution than the current delivery model for the Research Training Scheme delivery, which is only available to a small group of researchers each year.

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