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Evaluating Research Impact in Computing: A Slippery Slope?

This article draws on recent experience of approaches to research measurement in an Australian and New Zealand University context, where governments and policy makers are actively experimenting with ways of measuring research impact. Perhaps, as governments grant substantial support to university research, that *"leads to a natural concern for value for money on this 'investment'"* [11], and in a competitive research setting with demand outstripping funds available, valid mechanisms are sought for comparing the relative merits of research proposals [6]. Thus, evaluating the impact of research is an active theme within a wider research accountability agenda permeating UK and the Commonwealth countries. A comparable approach in the US context arising from the *America COMPETES Reauthorization Act of 2010* [20] can be seen in the National Science Foundation's inclusion of a broader impacts criterion to complement the key quality criterion of intellectual merit for evaluating research funding applications [19]. So similar policy directions for research funding and evaluation are apparent on the Western global stage. But what are reasonable limits for these accountability tentacles to stretch?

In our part of the world, the Australian Government recently circulated a proposal to evaluate research engagement and impact [3] in the context of a National Science and Innovation Agenda.

The rationale for the exercise was outlined in the quote below [3, p.3]:

> Existing systems of research evaluation (such as ERA [Excellence in Research for Australia] regarding research quality) show that the transparent reporting of university performance will drive institutions to modify and improve their behaviour. It is anticipated that the assessment and reporting of a university's performance in both research engagement and impact will lead to greater collaboration between universities and research end-users and incentivise improved performance in the translation and commercialisation of research. This in turn will deliver economic and social benefits and maximise the value of Australia's public investment in research.

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In June 2016 *CoRE* (the Australasian Computing Research and Education body), provided a submission in response [13]. As a member of the group preparing that submission, I found this a highly thought provoking exercise. In working through the details of the proposals and how they might apply to academics in the computing fields, we were led to enquire both deeply and widely. Enquiry ranged well beyond the computing field, both to better understand the policy context in which this debate had been framed, and to produce a coherent response. Here I reflect on these notions of research engagement and impact, their policy origins, and how they might affect the lives of computing academics and educators.

As Biersteker has noted, *"Scholars, and their intellectual tools, are invariably a part of the social and political contexts of their own investigations"* [5], so we cannot afford to stand aside from our own contexts and current debates such as these. Increasingly we see new economic policy initiatives, which have the potential to severely intrude on the lives of academics in today's universities. As Keynes [17] cited in [5] opined:

> *"Practical men, who believe themselves to be quite exempt from any intellectual influences, are usually the slaves of some defunct economist. Madmen in authority, who hear voices in the air, are distilling their frenzy from some academic scribbler of a few years back".*

The Australian proposals on measuring research engagement and impact have arisen in the context of the rise of per-

	Neoliberal	Liberal
Mode of operation	Private	Public
Mode of control	'Hard' managerialism; contractual specification between principal-agent; autocratic control	"Soft" managerialism; collegial – democratic voting: professional consensus; diffuse control
Management functions	Managers; line management; cost centres	Leaders; community of scholars; professions; faculty
Goals	Maximise outputs; financial profit; efficiency; massification; privatization	Knowledge; research; inquiry; truth; reason; elitist; not-for-profit
Work relations	Competitive; hierarchical; workload indexed to market; corporate loyalty; no adverse criticism of university	Trust; virtue ethics; professional norms; freedom of expression and criticism; role of public intellectual
Accountability	Audit; monitoring; consumer-managerial; performance indicators; output based (ex-post)	"Soft" managerialism; professional-bureaucratic; peer review and facilitation; rule based (ex-ante)
Marketing	Centres of excellence; competition; corporate image; branding; public relations	The Kantian ideal of reason; specialization; communication; truth; democracy
Pedagogy/teaching	Semesterization; slenderization of courses; modularization; distance learning; summer schools; vocational; Mode 2 knowledge	Full year courses; traditional academic methods and course assessment methods; knowledge for its own sake; Mode 1 knowledge
Research	Externally funded; contestable; separated from teaching; controlled by government or external agency	Integrally linked to teaching; controlled from within the University; initiated and undertaken by individual academics

Figure 1: Ideal type model of internal governance of universities [23, Figure 1]

formance driven approaches to research management (e.g. RAE/REF [Research Assessment Exercise/Research Excellence Framework] in UK, PBRF [Performance Based Research Fund] in New Zealand, ERA in Australia cf. [1,5,16,24,25,28]). I have previously written on the harmful impact these policy directions have had on computing academics and computing education in particular [11,12]. So what then might be the drivers of current policymakers' obsessions with the quantification of academic work?

To attempt to answer that question necessitates a detour from the computing disciplines into the world of economic theory. Olssen [22,23] usefully charts the rise of the neo-liberal economic agenda and its impact on higher education. The eschewing of the notion of the "common good" by the social scientist Schumpeter, set the scene for subsequent economic theorists of the 'new right,' basing their models on controlling the perverse actions of supposedly self-interested rational actors. Olssen illustrates the progression from professional to more managerial models of control, resulting in a more activist form of steering of the higher education system by neo-liberal governments. A comparison of the two differing world views inherent in the classic 'liberal' conceptions of the university and the 'neo-liberal' framing are depicted in Figure 1.

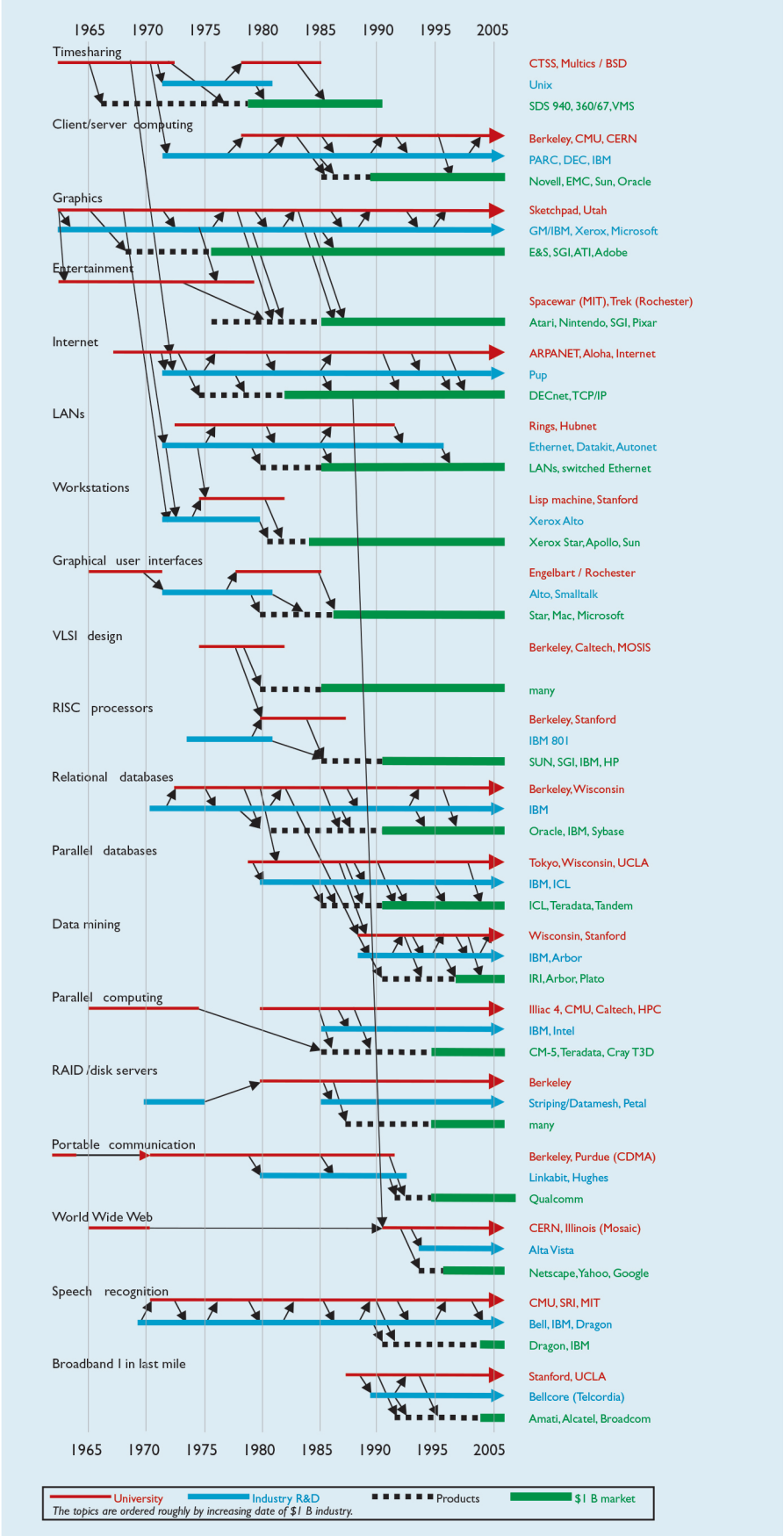
From a neo-liberal perspective then, the aim of the research engagement and impact assessment agenda becomes clear. In a sense we see "academic capitalism" as the perspective driving the university-industry engagement rhetoric, and an accompanying valorization of disciplines with "close affinity to the market." [2] As a result, such research activity has the assumed ability to "deliver economic and social benefits and maximize the value of Australia's public investment in research." [3, p. 3]

So what is the role of computing education and research in this agenda? While many of the computing disciplines have demonstrable (if not easily and directly traceable) links to market impact—such as in the tire tracks diagram in Figure 2—how would Computing Education Research (CER) fare in such a measurement regime?

There may be some models to complement the sole focus on economic impact that could be applied, such as the adapted payback framework developed as part of a RAND corporation analysis of Arts and Humanities research at the University of Cambridge [18] shown in Figure 3, which makes explicit the mutually reinforcing impacts of teaching and research. The study used illustrative case studies of humanities researchers to show how the model applied and was able to demonstrate the trajectories of their research.

But such exercises end up being largely justificatory and artificial case study exercises to suit accountability and funding steering mechanisms such as this UK example [16]. As Penfield [22] observes, many academics disagree with the evaluation of research impact, and share concerns about blue skies research being squeezed out in favor of research for which it is easier to demonstrate economic impacts or to explain to the public. Collini [22] critiques the ability of impact assessors to even validly perform the function, and notes that, in assessing impact, audit panel members will need to become "implausibly penetrating and comprehensive cultural historians." Olssen in his critique [22] shares two key concerns regarding the misguided steering of research and the inability to predict outcomes: 1) that the neo-liberal agenda "signals a significant modification to the liberal values of individual rights and freedom concerning research;" and 2) "a danger that in trying to second-guess good research in advance by assessing and funding it in terms of 'impact,' the very preconditions of discovery and innovation that are central to our futures and our conceptions of ourselves as free liberal beings are being undermined."

In the case of computing and IT we have seen two recent reports published highlighting the *"$1 Trillion economic impact of software"* to the US and world economy [8], and of ICT to the "tech" economy in New Zealand [21]. Yet what is it that underpins this contribution, but



skilled and well educated individuals? So the multiplier effect of computing education is significant, yet frequently goes unnoticed and unremarked!

However, when we come to Computing Education Research (CER)—through which we seek to better understand how learners learn and how educators may teach the specialized topics in the field—we see a lesser status accorded than to research within the discipline [10]. However, through work such as that by Sally Fincher and Marian Petre in publishing their book on how to do CER [14], and Simon's recent PhD thesis proclaiming CER as a discipline in its own right [27], we see progress towards recognizing this important field of scholarly endeavor.

In their report on research impact, the Small Advanced Economies Initiative (SAEI) did come out with a framework which goes beyond the solely economic perspective and could have utility for researchers applying for funding and wishing to create an optimistic story for their funding bodies [15]. Rather than impact measurement post-hoc, the approach suggests alignment of research programs to potential impacts, which is at least justifiable from a research funding body's point of view. Their framework has six pillars (*Economic; Health; Environmental; Public policy, services and regulation; Human capacity; and Societal and international engagement*) and three cross-cutting themes, which can be presented in an impact matrix, such as that in Figure 4.

How might this work for CS-Ed research? A partially worked example is presented in Table 1.

While the assessment in Table 1 could obviously be improved by greater quantification of benefits, it is indicative of one approach that could be adopted in demonstrating impact of a research program. It certainly demonstrates the significant potential for value to be generated in multiple spheres by a CER project.

Figure 2: Tire tracks diagrams showing University research, industrial research and development, and the emergence of products, and $1 billion markets spawned from computing research [4].

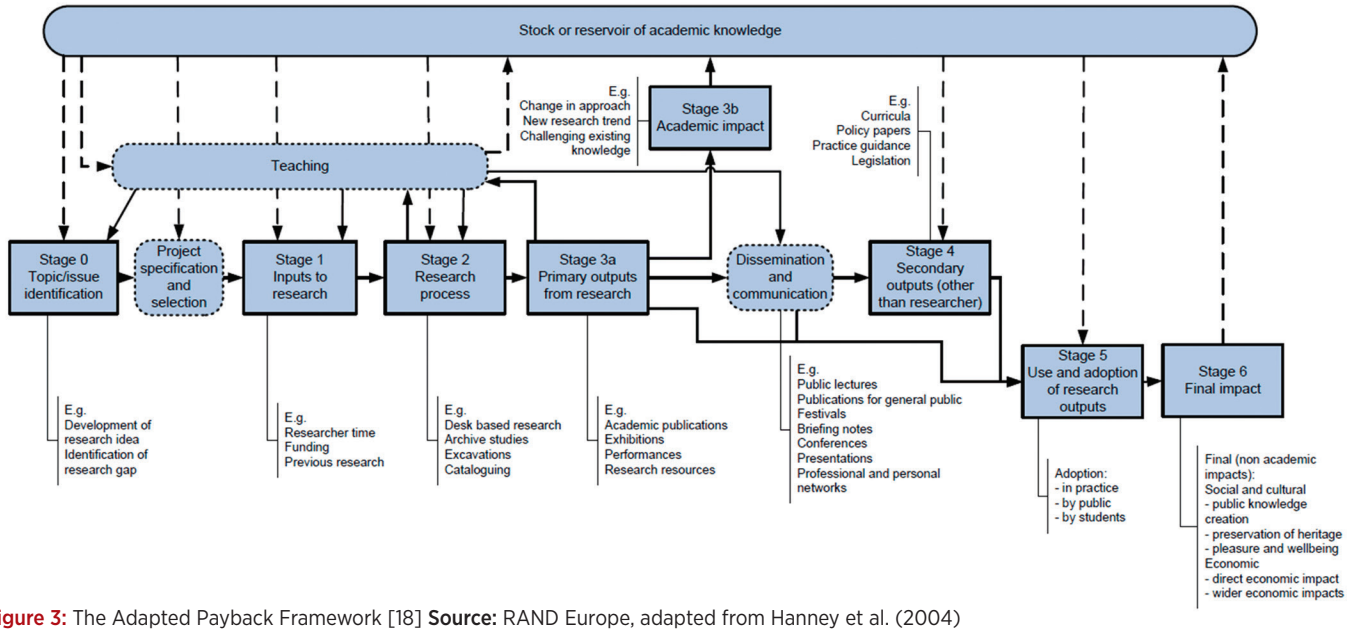


Figure 3: The Adapted Payback Framework [18] **Source:** RAND Europe, adapted from Hanney et al. (2004)

Table 1: Impact Matrix for a research program into the novice programmer

Area of Investigation	Impact Pillar					
	Economic	**Environment**	**Health & Wellbeing**	**Policy & Public Services**	**Human Capacity**	**Society and International**
The novice programmer-reading and writing code (new products etc.)	Multiplier value of resulting graduates increasing the value created by software related industry and research organisations	Potential impacts through graduates working in 'green computing' or new applications in environmental sectors	Potential impacts through graduates developing new health sector software services and products	Potential impacts through graduates developing new public sector software enabled services and products	New learning and teaching approaches lead to growth in successful graduates and to number of highly skilled employees in software and IT related industry, service and research organisations	Potential impacts through graduates developing new software originated products/ services contributing to society within countries and in global settings
The novice programmer-reading and writing code (efficacy of practice)	Multiplier value of more highly skilled graduates as employees increasing the value created by software related industry and research organisations	Potential impacts through sensitised graduates with 'green computing' awareness and commitment to new applications in environmental sectors	Potential impacts through expert graduates driving innovation in health sector software services and products	Potential impacts through expert graduates' better design and delivery of efficient and inclusive public services and products	Research based insights lead to improved learning and teaching approaches and student success and educator satisfaction, building a stronger graduate pipeline	Potential impacts through expert graduates' better design and delivery of efficient and inclusive products/ services meeting local and global needs
The novice programmer-reading and writing code (resilience or sustainability)	Reduced waste and cost to students and educational institutions due to dropout and failure	Potential for a more inclusive learning environment (computing for the social good)	Improved student and educator wellbeing	Improved ability to provide needed public services that are convenient and affordable	More productive and successful teachers and students retained in the system	NZ S/W SMEs Improved awareness of global customer needs and to position for emerging niches

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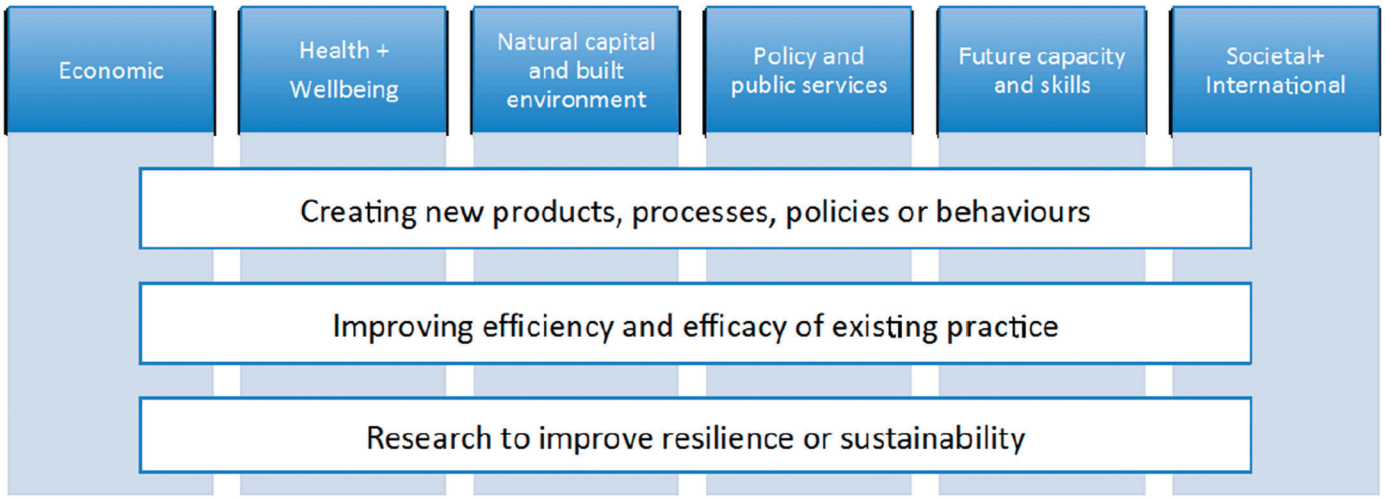

Figure 4: Small Advanced Economies Initiative Impact Framework (6 pillars of impact, together with cross cutting themes) [15]

But in considering the applicability of mechanisms such as this SAEI framework, the question remains—will impact assessments help us to do better research with a clearer focus on the stakeholder and beneficiaries? Will they help us in our funding bids by telling better stories, or merely demand compliance and a degree of duplicity in embellishing our applications, for example, see [9]? Can we retain integrity in our own curiosity driven research programs, or will we be inevitably tied to externally imposed research agendas? In this disturbing policy context we will simply need to remain eternally vigilant! ❖

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