COLLABORATION, KNOWLEDGE & THE TRANS-DISCIPLINARY MANAGER: *Helping interdisciplinary research projects to flourish*

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Abstract:
Research has been conducted into the special nature of interdisciplinary academic work *per se* and towards resolving the particular difficulties faced by interdisciplinary researchers. Some of the findings of two recent Australian studies into ways to strengthen interdisciplinary research are reported here.
In 2012, the Chief Scientist of Australia commissioned ACOLA to undertake a three-year, $10 million program of research under the title *Securing Australia's Future*. The program involves Fellows of the four Australian Learned Academies and embraces issues as diverse as underground engineering for the exploitation of shale gas deposits; how to maximize the translation of innovation and research into productivity; and a critique of the country's engagement with the Asia-Pacific region.
The requirement to deliver at Cabinet level interdisciplinary evidence-based policy options for government, suggests that public policy experience in dealing with "wicked problems" has insights to offer those engaged in interdisciplinary academic research.
An emerging group of trans-disciplinary project managers may help interdisciplinary research projects to flourish.

Key Words: ACOLA, Australia, interdisciplinary research, research management, trans-disciplinary management, wicked problems

Introduction:

There are 39 universities in Australia[1], providing a home for more than one million enrolled students and 100,000 full-time equivalent staff[2]. Most of those universities "developed as a result of amalgamations of teacher's colleges and other post secondary training institutions such as Institutes of Technology during the 1980s."[3] In the *2012-2013 Times Higher Education World University Rankings*, just 6 Australian bodies fall inside the top 100 universities world wide.

Collectively, Australian universities undertake some $5.4 billion worth of research and development each year. A much-quoted statistic is the fact that with only 0.3 per cent of the world's population, Australia produces 3 per cent of the world's research papers.[4] Still, Australian universities have a strong vocational mandate: "almost all students undertake study at undergraduate level in a professional discipline, class sizes are high and teaching workloads are heavy. For most academics, undertaking a personal research programme within this educational culture is extremely difficult." [5]

Unsurprisingly then, Australia remains a net importer of research. A recent study conducted by the Australian Council of Learned Academies (ACOLA) for the Federal Government[6] confirmed that many researchers are concerned about the uncertainty of research funding; the scarcity of fellowships and grants; and workload issues.

For years there has been an almost constant series of *Government initiatives* to increase

1 www.australianuniversities.com.au/rankings

2 www.universitiesaustralia.edu.au/page/australia-s-universities/key-facts---data

3 Wellstead

4 Carr and elsewhere

5 Wellstead

6 ACOLA *Career Support for Researchers*

research outputs from Australian universities. Most recently we had the *Excellence in Research for Australia* project, which set out to assess research quality within Australia's higher education institutions using a combination of indicators and expert-review (by committees comprising experienced, internationally recognised experts). Overlapping with that has been the ongoing *Research Workforce Strategy* project, which aims to ensure that the country has the quantity and quality of researchers needed to 2020 and beyond.

These initiatives to stimulate research take place against a background in which Government is already heavily invested in research. For the last 10 years, Australia has not only been determined to win a disproportionate number of Olympic medals. We have also boasted a set of "national research priorities". There are four of these:

- *An Environmentally Sustainable Australia*
- *Promoting and Maintaining Good Health*
- *Frontier Technologies for Building and Transforming Australian Industries*
- *Safeguarding Australia*

The priorities are today defined by twenty-one priority goals. These goals[7] are focused on outcomes and they cover research in a range of disciplines, ensuring that not only natural and applied sciences but also social sciences and humanities research is targeted. I mention them here because they provide an official foundation or charter, on which to build a culture of interdisciplinary research.

The past ten years are arguably exactly the period in which we have begun to fully understand the importance of an unrestricted, cross-fertilised approach to problem solving. While the integrity of the traditional academic disciplines may still be defended in the case of research that is curiosity-driven, seeking purely to expand our realm of knowledge, it is in research directed towards problem-solving that the restrictions of the disciplines become most apparent. So the twenty-one priority goals help to ensure that pure science is considered within the context of applied technology; that both of those are understood in respect of their economic, ethical and social implications; and that we never lose sight of the understanding, engagement and responses of the broader community.

The single most important publicly-funded non-academic research organization in Australia is the Commonwealth Scientific and Industrial Research Organisation. CSIRO is the national science agency and one of the largest and most diverse research agencies in the world. For the purposes of this paper, the most interesting aspect of CSIRO is the establishment in 2002 of its National Research Flagships initiative. The Research Flagships were conceived as "large scale multi-disciplinary research partnerships harnessing world class expertise from within CSIRO and partner organisations to tackle a range of national challenges and opportunities. A focus on outcomes, with each Flagship having a detailed strategy for delivering research solutions that target clearly defined goals, was a further distinguishing characteristic of Flagships compared with other research initiatives."[8]

There are ten Flagships today, covering many of the same broad areas of interdisciplinary effort suggested by the National Research Priorities: biosecurity, climate adaptation, energy, food security, manufacturing, minerals, the oceans, preventative health, sustainable agriculture and water.

Another publicly funded initiative is that of the *Co-operative Research Centres* (or CRCs). A CRC is an organisation formed through collaborative partnerships between publicly funded researchers and end users. There are currently 37 active CRCs in Australia and each of them includes at least one private, public or community sector end-user, as well as one Australian higher education institution, or a research institute affiliated with a university. Because CRC funding is substantial and extends over many years, the competition is very stiff. Nowadays, CRC research is characterized by the fact that it is user driven and often embraces studies with specific commercial potential. As such, there are many examples of interdisciplinary research within CRC, the most famous of which is probably that of Graeme Clark, which led to the development of the cochlear implant – the so-called "bionic ear". There are CRCs in agriculture, forestry and fishing; manufacturing and mining; and in

7 See Appendix 1

8 www.anao.gov.au/bpg-innovation/case-6.html

the service industries. A report by the Allen Consulting Group[9] calculates that CRCs have already delivered an $8.6 billion impact on the economy since the initiative began in 1991. The most recently established CRC is called Young & Well, which explores the role of technology in improving young people's mental health and wellbeing. The Young and Well CRC is made up of over 70 organisations from across the not-for-profit, academic, government and corporate sectors.

Finally, there are two principal public organizations through which most of the Federal Government's financial support for individual research projects is channeled: the *Australian Research Council and the National Health and Medical Research Council.* Both are statutory bodies that not only manage millions of dollars of research funds through various programmes, they also provide advice to the Federal government on research matters.

This then is the environment in which ACOLA, the *Council of Learned Academies*, seeks to encourage research and scholarship across the disciplines. As the forum for inter-Academy cooperation, ACOLA (and its forerunner the National Academies Forum) has been responsible for delivering a number of well-regarded reports in areas where an interdisciplinary approach was particularly called for. These have included, for example, **s**tudies in the areas of nanotechnology, attitudes to nuclear power, the impact of climate change on culture and other topics where an interdisciplinary approach is essential.

It seems fair to conclude from the above that developments in Australia have mirrored those across the world, in that it is possible to find the roots of interdisciplinarity stretching back at least forty years, but it is the last ten years that have seen formal recognition and a rapid acceleration of this kind of activity. Perhaps – as I intend to explore as the main thrust of this paper – it is the challenge of "wicked" problems such as climate change, drug trafficking, population growth, poverty and waste – and our contemporary imperative to struggle for solutions to these – that has helped to stimulate interdisciplinary research.

Research into interdisciplinary research in Australia

For the last two years, ACOLA has been undertaking a study funded through the Australian Research Council into the question of interdisciplinary research in the area of sustainability. This multivalent program of research is designed to address two outstanding problems, one a key issue in research management, the other a national challenge. The former is the application of interdisciplinary research to the broad, problem-based research agendas of today and tomorrow. The latter issue – addressed as a test case for the methodological work conducted in the first part of the program - is how to use this understanding to find effective ways of approaching the array of challenges confronting Australia in growing our population, sustaining our way of life and our living standards, reducing our burden on the environment, promoting social harmony in a context of diversity, and advancing our nation's role as a leader in the global community.

The study has thus far produced two reports: *Strengthening Interdisciplinary Research: what it is, what it does, how it does it and how it is supported*, authored by Gabriele Bammer and an as yet unpublished report *Achieving a Sustainable Australia* completed by Michael Webber in the last few months.

These consecutive reports have identified some of the most important challenges confronting interdisciplinary research and its management and offered strategies for addressing those. As examples of current academic thinking about interdisciplinary research *per se* in Australia. I propose to briefly summarise some of the findings of those reports. Then I will move onto the major research program with which we are currently engaged and a discussion of the lessons we are learning from the practical application of this theory.

Bammer

The Bammer report makes a number of recommendations including the establishment of a classification for the major kinds of interdisciplinary research; the standardization of reporting systems; the development of useful strategies as "toolkits" (these might be described as clusters of strategies, which provide a range of options for conducting different aspects of interdisciplinary

[9] Allen Group *Impact of CRCs*

research); the development of a data collection system about the different kinds of research currently being undertaken, their quality, and the best way of educating the next generation in skills in interdisciplinary research.

Bammer identifies a role not only for researchers and research organisations, but also for government policy makers and the full range of research funders, including business and philanthropies.

Webber

In the second phase, we planned to survey the interdisciplinary research landscape and conduct case studies across Australia within different research environments, including universities and private organisations. We were looking for the best and the worst, for examples where the interdisciplinary research approach has worked particularly well – and then examples where the going has been a lot more difficult.

Michael Webber set out to discover: what can we learn? What are the generic lessons? Is there a degree of commonality amongst the success stories? Webber is a social scientist and a geographer. His primary concerns in this report are the environmental bases of sustainable societies – the relationship between environmental variables on the one hand and the long-term wellbeing of societies on the other. But he points out that "societies can only continue to function if they meet certain conditions... such as class relations, forms of governance, intergovernmental relations, investment and education." [10] Most of these conditions, essential to the sustainability of societies, are things we don't currently understand. All of them are meaningfully approached only in an interdisciplinary fashion.

Webber borrows the term *trans-disciplinary research* to describe research "that involves decision makers, policy makers and researchers from more than a single discipline".[11] One of the problems that Webber highlights is the need for those engaged in this trans-disciplinary research – at least in the area of sustainability – to play three roles: first as scientists, who provide knowledge; second as intermediaries, who must "interrelate epistemological, conceptual and practical elements that were not related before"[12]; and finally as facilitators, helping the process of communication between different disciplinary concerns as well as the end users. "The problems," he writes, "are that natural and social scientists are not trained in these second or third roles, and that they take time away from the first role (which researchers think is their 'real job')".

Neither Bammer nor Webber deals with the role of research managers of interdisciplinary projects. In the concluding section to this paper, I will propose that at least one or more of the roles forced on those engaged in such research could be (and sometimes already are) more usefully played by appropriately qualified research managers.

The research program *Securing Australia's Future*

The Australian Government has identified the "opportunities and challenges of an economy in transition" as a key issue facing the nation. Maintaining the *status quo* is not seen as an option. It is therefore critical for substantial consideration to be given as to how different sectors of the Australian society and economy can be encouraged to be as adaptable as possible in times of national and global changes.

The challenges include: (i) changes, of varying degrees, to all aspects of what we might call the current Australian "niche"; and (ii) the global environment in which Australia will be required to compete.

To secure Australia's future, it is crucial to understand how best to stimulate and support creativity, innovation and adaptability, across industries and in our communities; to have an education system that values the pursuit of knowledge across all domains, including the benefits of science, technology, engineering and mathematics; and to be more willing to support change, through effective

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risk management. All of these elements are important in considering how to drive Australia's productivity and economic growth.

The Government has therefore decided that interdisciplinary and collaborative research should be undertaken by Australia's four Learned Academies, to deliver an intersecting series of studies to inform policy development, through the Office of the Chief Scientist of Australia.

In 2012, the Prime Minister's Science, Engineering and Innovation Council (PMSEIC) identified six initial topics for research and development:

1. Australia's comparative advantage
2. STEM: Country comparisons
3. Asia literacy – language and beyond
4. The role of science, research and technology in lifting Australian productivity
5. New technologies and their role in our security, cultural, democratic, social and economic systems
6. Engineering energy: unconventional gas production

Each of these topics has discrete challenges to be explored, but they are obviously multifaceted, crossing a range of related matters and interconnecting with social, cultural, scientific, economic, technological and governance factors.

At appropriate stages within each project, ACOLA will publish formal research reports, in consultation with the Office of the Chief Scientist, and new topics will added to the initial six, as the work progresses.

The three-year program is governed by a Steering Committee, comprising three Fellows from each of the Learned Academies. The projects have different reporting deadlines, ranging from nine months to thirty-six months, but each project has an Expert Working Group, made up of a mixture of Academy Fellows and subject-area specialists. Many of the projects will also commission specialised work from external consultants. Managing this program for ACOLA has thrown up the most significant challenges imaginable for the Secretariat.

While colleagues across the research sector have seen their funding cut, we have all the problems of the *nouveau riche*! The budget we control is suddenly 50 times bigger than a year ago. We have had to increase our staff from 1 to 5 people, we have moved offices, bought computers and hired consultants, to help us rapidly develop the systems we need to manage the new program. In short, we have all the challenges associated with a successful start-up company.

And least we become too ostentatious with our new wealth, hanging over it all is a reminder of the *vita brevis*: the program will last just three-years and then presumably, it will end. So for that too we must plan.

For the purposes of this paper, the hidden value of the program lies in providing us with an opportunity to test some of the ideas put forward by Bammer and Webber and others; to see if we can help identify good practices in successfully managing large cross-cutting research projects; and even to ask if there is a distinctive approach to interdisciplinary research management that might be called for.

Good management practices

Bammer's[13] recommendations might be summarized as:

1. Understanding the difficulty of the problems being tackled and the likelihood of developing clear cut solutions
2. Being clear about the number of perspectives that will need to be considered
3. Identifying the work as (existing) unit-based or project team-based (matrix)
4. Anticipating the ways in which disciplines will be coupled or transcended
5. Planning for the degree of engagement with end-users that will be required
6. Considering the power and standing of the various contributors; and finally
7. Examining the institutional arrangements in which the work will take place

13 Bammer G

Webber[14] builds on these concepts and offers the following practical suggestions:

1. Appoint a carefully chosen leadership group, formed before the project begins, that includes project managers, communicators, facilitators and statisticians – as well as scientists – rather than representatives of different disciplines
2. Consider the time, cost and technological means of communication – whether this is face-to-face meetings, teleconferences, video-conferencing or e-mail
3. Plan the project around tangible tasks, so that groups spend their time arguing about specific decisions and activities, not abstract concepts
4. Answer the question up-front as to whether the project is to be driven by supply (by the end-users) or demand (by the leadership group). Make contact early with the real stakeholders and keep them engaged
5. Understand the role (if any) of commercialization for the project
6. Establish and maintain documentation for the project
7. Recognise that team members have other responsibilities than to the project; take this into account when planning the timing of contributions
8. Create spaces for sharing – sharing ideas, sharing data
9. Allow for succession, including the training and mentoring of junior researchers

The 2005 National Academies publication *Facilitating Interdisciplinary Research*, describes the key conditions for successful interdisciplinary work. "They include sustained and intense communication, talented leadership, appropriate reward and incentive mechanisms (including career and financial rewards), adequate time, seed funding for initial exploration, and willingness to support risky research." [15]

The National Academies' study offers recommendations for team leaders:

Bring together potential research collaborators early in the process and work toward agreement on key issues by:

- Catalyzing the skillful design of research plans and the integration of knowledge and skills in multiple disciplines, rather than "stapling together" similar or overlapping proposals
- Establishing early agreements on research methods, goals and timelines, and regular meetings

Seek to ensure that each participant strikes an appropriate balance between leading and following and between contributing to and benefiting from the efforts of the team, by:

- Helping the team to decide who will take responsibility for each portion of the research plan
- Encouraging participants to develop appropriate ways to share credit, including authorship credit, for the achievements of the team
- Acquainting students with literature on integration and collaboration
- Providing adequate time for mutual learning

The more specific all these recommendations become, the more they seem to converge with the sort of approaches that one might expect from any competent project manager. A few of the points raised in the reports cited might be particularly applicable to interdisciplinary research projects, but many of them are not even unique to the research sector. And yet, as we worked towards developing structures and policies appropriate to the multi-faceted program for which ACOLA is now responsible, I began to hear a familiar ring. More and more, it seemed to me, the complexity of the issues we were to begin researching and the factors we would have to consider in approaching this resembled what I had been trained in the public policy sector to recognize as a "wicked problem".

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15 National Academies *Facilitating Interdisciplinary Research*

Since there is a small, specialized literature about the management of wicked problems, I wondered if we might find useful ideas there about successful management in the interdisciplinary sector.

Public policy and wicked problems

The phrase "wicked problem" was used by the Berkeley designers Horst Rittel and Melvin M. Webber in 1973 to describe problems which unlike (some) mathematics, chess or ciphers, do not have "tame" solutions. Rittel and Webber provided a ten-step list of the characteristics of wicked problems[16]. The similarity between some of the sort of complex problems that seem to call for an interdisciplinary or even a trans-disciplinary approach and what are described as wicked problems is not really surprising. A number of contemporary references can be found to the specific value of interdisciplinary research in approaching wicked problems.[17] What is not often described is the fact that the management of inter- or trans-disciplinary research often raises some of the same challenges as the management of 'wicked' problems.

Shared characteristics

Here expressed in research terms is a brief list of the seven most obvious characteristics that wicked problems have in common with the sort of complex issues often dealt with in interdisciplinary research:

1. The research goal is *hard to clearly define;* there may be more than one version of the 'truth'; there is a lack of reliable quantitative data; unbounded systems defeat the value of individual experiments
2. There may be *internally conflicting objectives* within the broader issue; multiple stakeholders seek varying outcomes; consequently there is a reluctance to synthesize knowledge
3. The problem or goal may be *a moving target*; the problem is relatively unique or unprecedented; or the problem is unstable, breaking down any definitive problem boundary
4. The research activity itself may lead to *unforeseen consequences* (the "observer effect"); earlier experiments or interventions may have changed or further complicated the nature of the problem; an orderly, linear approach is not possible
5. There may be *no clear outcome possible;* expectations of a single, definitive technological solution may be unrealistic; there may be no clear stopping point
6. *Social complexity* (the need for coordinated action by a range of highly variable stakeholders) rather than technical complexity may defeat current problem-solving and project management approaches
7. The challenge may require *changes in human behavior*, a new research methodology and/or a new commitment from individuals

Conclusion: *The trans-disciplinary management approach*

So how do we approach managing – at this stage – six different research projects of varying duration, that include problem-solving in the realm of cultural studies, economics, education, engineering, technology and politics?

What we are working towards is building a team of interdisciplinary project managers who can firstly act as facilitators, "helping the process of communication between different disciplinary concerns as well as the end users"[18] – the third of Michael Webber's characteristics of trans-disciplinary management; but also managers who have some capacity to act as intermediaries, as those "who must "interrelate epistemological, conceptual and practical elements that were not related before"[19]. This means recruiting people who share not only many years of project management

16 Quoted at http://en.wikipedia.org/wiki/Wicked_problem

17 Diesendorf & Rammelt; Wong *et al*

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experience, but who also have some training in the natural or social sciences. This is the approach we have been following.

Accordingly, our staff include project managers from backgrounds in medical research, social research and the development sector, as well as the arts. They also have experience in running government funding programmes; in working with philanthropic donors; in managing public companies and in working with the community sector. The team members bring different perspectives to bear on every activity: from designing our website, to establishing expenditure controls. There's so much constant, daily interaction across a very wide-range of challenges that I doubt that anyone has time to consider a discipline-based viewpoint. When we occasionally run into a point of view or an argument from a stakeholder that is obviously an entrenched position based within a single discipline it comes almost as a shock.

As facilitators, we expect of our project managers that they should be able to:

- Communicate constantly, effectively and patiently with a wide range of stakeholders
- Command and control resources and infrastructure, whether they be finances; travel and accommodation arrangements; meetings, workshops and conferences; contracting consultant researchers; or driving review and approval processes
- Maintain a detached integrity, an almost priestly commitment to good governance, so that legal compliance and financial accountability are always beyond reproach

As intermediaries, we expect our project managers to:

- Understand the historical tensions that exist between various world-views or schools of academic thought and take up the best that each has to offer, always emphasizing commonalities rather than differences
- Speak judiciously on behalf of Academy Presidents, senior Government figures and respected researchers, accurately representing their point of view when necessary
- Never lose sight of the "public good" – meaning not just what we might imagine is best for the country, but also how the man or woman in the street hears and understands the complex issues with which we work

And of course we face a series of challenges. The following points summarise our experience to date:

1. **We have created a working operational structure**
   The Program Steering Committee provides overall governance of the program across the three-year life span. Each project is provided with an Expert Working Group. Both the Steering Committee and the Working Groups include representatives of all four learned Academies, as do the Peer Review Groups for each project. Representatives of the Federal Government departments identified as the end-users of any policy options are regularly invited to join the Working Groups.

   There is a formal and comprehensive approval process for reports that involves independent peer review, approval by the Program Steering Committee and final approval by the Presidents of the four learned Academies.

2. **We have a complex power structure:**
   We aim to settle upon the collaborative power structure that is usually recommended for tackling wicked policy issues[20] and within some project areas that does exist.
   In the larger sphere of the program as a whole, the power structure is more accurately described as 'authoritative'. Competition exists over who will approve what and over which resources will be allocated to whom.

20 APSC *Tackling Wicked Problems*

3. **We strive to maintain a holistic approach**
   The Office of the Chief Scientist, who commissioned the research program on behalf of the Government, encouraged the Academies to avoid the temptation of taking a linear approach, by drawing the initial planning boundaries too narrowly. A lot of time, six months in fact, was put into scoping each of the projects in some detail. In those project areas where the research, findings and recommendations become truly innovative, we will succeed in finding the unforeseen consequences for the whole. In other cases, we may find only what we looked for.
4. **We work towards maximising the value of a broad collaboration**
   We have assembled a cast of scientist and consultants who are highly respected in their fields. Some scientists have more experience of working in the public policy arena than others. The usefulness of the final reports that we generate is likely to depend on ensuring that the broadest perspectives prevail.

5. **Our Secretariat adds value**
   We have established a Secretariat with responsibility for capturing and disseminating all the available information and data as it is gathered. The Secretariat is also responsible for managing, directly or indirectly, the projects themselves. In some instances we have sub-contracted aspects of the project management to seconded staff.
   The Secretariat has developed appropriate systems for the management of information and to ensure legal compliance. The Secretariat can therefore take full responsibility for budget controls and financial transparency, however unpopular that makes us. Still, a really good secretariat should be far more than just a gatekeeper.
6. **We are rising to the challenge of thinking and working in new ways**
   We began scoping this venture a year ago in a pioneering spirit of experimentation and adaptability. *Securing Australia's Future* is easily the biggest interdisciplinary research program ever embarked on by Australia's Learned Academies. There certainly have been interdisciplinary collaborative ventures larger than this undertaken in Australia before, but perhaps not in the specific field of academic research expected to deliver workable options in the public policy arena.

   Now I'm not persuaded that we have yet built enough all-round commitment to finding what you might call the 'clusters of solution-probability' (to butcher the terminology of stochastic processes) that lie in the trans-disciplinary zone, well beyond the point where disciplines intersect, or what has been called "the unity of knowledge beyond disciplines."[21]
   I will end with a quote from *The Glass Bead Game* by Herman Hesse[22] in which Joseph Knecht expresses what might be the cry of today's interdisciplinary research manager:

   "If only there were a dogma to believe in. Everything is contradictory, everything tangential; there are no certainties anywhere. Everything can be interpreted one way and then again interpreted in the opposite sense. The whole of history can be explained as development and progress and can also be seen as nothing but decadence and meaninglessness. Isn't there any truth? Is there no real and valid doctrine?"

[21] Nicolescu B
[22] Hesse H *The Glass Bead Game* 1943

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