INTERDISCIPLINARY COLLABORATION IN CONTEXT: ACADEMICS AND AGENDAS

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Interdisciplinary collaboration in context: academics and agendas

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Abstract

Collaborative interdisciplinary research is increasingly pursued as a multipurpose response to a range of academic problems and opportunities: intellectual, institutional and societal. Empirical research into individuals' experiences and perceptions of doing interdisciplinary research in the context of competing demands is needed to understand the potential and challenges interdisciplinarity poses. This report describes the final phase of a four year study at The University of Melbourne - the 'MICE project' - that has taken such an approach. Using the lens of a seed grant program at the University, it explores participants' views of the process, outcomes and context of doing interdisciplinary research. Its purpose is to provide feedback to University management and help address the need for detailed empirical work on interdisciplinarity in practice. It argues that while collaborative interdisciplinary research is hard work, and people's experiences of it are strongly context specific, it is generally highly valued by those involved and is delivering a wide range of benefits. As such, it deserves ongoing support, including efforts to address the ways its potential remains constrained by various practical, political and structural factors.

Executive Summary

Interdisciplinarity is a diverse, ambiguous and increasingly popular mode of research, valued by different people for different things. How it is defined varies according to how it is imagined to relate to disciplinarily and disciplines, which also vary in meaning. The rising profile of interdisciplinarity reflects the fact that it is perceived to address the dominant institutional logics in contemporary Australian academia - the productivity, excellence and impact agendas - although to others its value lies in the alternative it offers to these. Universities express or 'frame' what they count as valuable research through the combined influence of their structures, systems, policies and messages. Individuals interpret this framing in dynamic and context-specific ways, shaped among other things by their position within the organisation.

Taking a broadly interpretivist approach, this report is the final product of the four year 'MICE' (Melbourne Interdisciplinary Collaboration Exploration) project. It examines the practical, political and philosophical aspects of individual researchers' experiences of interdisciplinary research collaboration in relation to four intersecting contextual factors: research policy, agenda and organisational structure; individuals' disciplinary and epistemological outlook; their research projects, group, topic and processes; and their career paths and inclinations. The MICE project used the University's Interdisciplinary Seed Grant program (ISG) as an empirical window onto academics interdisciplinary collaboration experiences in the program and beyond. The ISG funded 90 projects, with an additional 58 projects funded directly by the University's thematic research institutes between 2010 and 2013. This report stems from the second phase of the MICE project, based on 75 survey responses and 15 interviews with ISG participants in the 2012 and 2013 rounds and focused loosely on academics in the Humanities and Social Sciences.

Respondents were strongly positive about their experiences with their ISG projects, judging them a success and reporting many positive outcomes. Nearly all reported one or more academic publications and approximately half reported having already submitted a larger grant application. Respondents' strong focus on such outputs indicates their awareness of the importance of such conventional academic measures of success. At the same time, in keeping with broadening measures of academic success, the projects were described as leading to many other outcomes such as public reports, new ideas, new relationships, and enhanced professional visibility. Combined with more personal benefits it appears the projects provided multiple sources of institutional, intellectual, social and emotional 'capital'. Many respondents indicated a highly strategic attitude towards the grants in relation to their careers, viewing them as a targeted stepping stone towards specific goals. Others had a more open-ended approach and discussed the projects as an experimental type investment that could generate - and often was generating - numerous unexpected positive 'spin-offs', including developments that help link researchers into emerging international fields and networks.

While the majority of projects were catalysed by the availability of the seed funding, they varied in the extent to which ideas or groups were pre-formed at the time of the grant call. Reflecting prior experience and preferences, respondents also varied in which of the two - strong topic or strong team - they prioritised as most essential to project success. Indicating that most managed to "get it right" in their projects, 92% reported they expected to keep working with at least some members of their project group, with 83% reported that

they expected to keep working on the research topic over the long term. These expectations also point to the ideal of various types of continuity in researchers' work, captured in the notion of a "track record". For some researchers (notably those in contract topic-based research) interdisciplinarity *per se* can be continuous but their focus on one topic or involvement in one group can be discontinuous to the extent they are vulnerable to the whim of shifting policy agendas or job insecurity. Combined with a lack of a clear disciplinary identity and institutional profile, this variability in research experience can ironically constrain their recruitment into new interdisciplinary research projects. Staff leaving projects early to take up new job opportunities was also mentioned as an obstacle to exploiting the potential of the projects and producing the desired academic outputs in a timely fashion.

Timing is a key pressure in the projects, not just or even in relation to sticking to the project's formal funding period but in relation to how the work and outputs involved articulate with individuals' and groups' concurrent work and plans, notably funding applications into which it is hoped the project outcomes flow. Thus, the ISG projects are viewed by researchers not only in terms of a project-specific research production cycle but in terms of a higher-level, personal research-reproduction cycle in which the goal is to link track record to subsequent opportunities. Some respondents reported that their ISG projects were formative in accelerating or redirecting their own or their students' or colleagues' professional progress.

Related to the multiple roles projects play in researchers' lives, researchers play multiple roles in projects. In part this reflects the changing nature of the tasks over a project's lifetime, alternating between different phases involving 'expansion' (e.g. topic exploration, identification of subsequent opportunities) and 'consolidation' (e.g. clarifying roles, settling on conclusions, producing outputs). Few groups seem to conceive of their projects in project management terms even though interdisciplinary projects - often complex and uncertain - arguably pose especially acute management and leadership challenges, especially if they are to achieve final 'consolidation'. These challenges are likely exacerbated if the project is being (informally) managed by an academic with little sway over, understanding of or engagement with other team members.

Uneven commitment to the ISG projects between team members was a commonly reported problem, pointing to the different roles the projects play in different researchers' careers and to the pervasive issue of time shortage. The relative time-intensity of interdisciplinary collaborations in terms of the face-to-face interactions they can require and their duration is arguably the main clash between interdisciplinarity and the dominant academic setting. Researchers also engage with the concept of interdisciplinarity in ways that are shaped by their organisational location and (inter)disciplinary identity, mediated by the views of those around them. Many interviewees identify with more than one discipline and sit within non-traditional organisational units within the University in which interdisciplinarity is normal. Those practicing interdisciplinarity within strongly disciplinary based parts of the University often seem to have high pre-existing institutional capital, and can benefit from how unusual their willingness to be interdisciplinary is.

Group and knowledge work are inseparable in interdisciplinary collaborations. This is clear when considering individuals' epistemological perspectives, which also shape how they conceptualise interdisciplinarity. The distinction between a broadly positivist and broadly interpretivist epistemology was described as a significant tension within the University. The "jigsaw" metaphor of integrating knowledge represents the dominant,

positivist approach. Here, the assumed commensurability of knowledge allows groups to adopt a "plan-to-integrate" process in which the primary challenge is mapping and linking knowledges. In contrast, a more interpretivist epistemology imagines interdisciplinarity as the bringing together of different "lenses" on the world in order to develop a new perspective. Here, the assumed incommensurability of different knowledges means groups need to adopt a more dialogical research process in order to either try to reach a sufficient degree of clarity and consensus or jointly create a new "language". Numerous researchers recounted the difficulties of working in cross-epistemological projects. Different members of an interdisciplinary project often bring not only different knowledge content but different notions of knowledge work, team work and interdisciplinarity. Neglect of this fact can hamper the intellectual and interpersonal quality of projects and lead those who feel misunderstood to withdraw emotionally and intellectually.

The extent to which researchers primarily orient their work towards academic peers or broader society combines with epistemology to shape the general stance researchers have with regards to interdisciplinarity. Four ideal-type stances are Pioneer, Expert, Critic or Catalyst. Most respondents in the MICE project seem to adopt a Pioneer stance in which interdisciplinarity is about crossing knowledge frontiers. While this can stimulate exciting work, if it is incorrectly presumed to be a shared stance it can create difficulties for those working with different motivations or from a more interpretivist perspective. In such cases, researchers from interpretivist backgrounds - who are more attuned to the possibility of different perspectives - are then sometimes called upon or impelled to do additional "group process" work within their projects to try to help the team develop a shared understanding of the knowledge work they are jointly undertaking.

Intellectual, interpersonal and resourcing difficulties were described by respondents at the project, individual and organisational levels. This includes the structural impediments to interdisciplinarity and the broader issue of how committed the University and sector is perceived to be to it. Numerous respondents suggested they had trouble linking up with others in the University and called for more opportunities to identify and meet like-minded others and engage meaningfully on important topics. Other recommendations encompass ideas about direct funding of or alternative specific support for interdisciplinarity (e.g. workshops on or showcases of interdisciplinarity), as well as changes to broader organisational factors (e.g. reform of Field of Research codes). In particular, there seems to be scope and desire for more interventions to foster interdisciplinarity not only at the level of small groups (projects), but at the levels of individuals (in their careers) and the (sub)organisation (e.g. through communities of practice), helping to embed transitory interdisciplinary projects into a broader, more durable movement towards interdisciplinarity. At the project level, the valuable risk-tolerance and open-mindedness of the ISG funding could be complemented with other funding characteristics thought to foster 'breakthrough research'.

Overall, the general feeling about the ISG scheme is very positive. At the same time, it exposes the need for further critical analysis of how interdisciplinarity sits within the University. While the broad institutional logics (productivity, excellence and impact) tend to encourage research collaboration (at least in the Science, Technology, Engineering and Maths (STEM) disciplines and the social sciences), they send very mixed messages about interdisciplinarity. The resultant tension produces the risk that the interdisciplinarity conducted is more superficial than that which could be achieved were the pressures upon people's time management, budgets, research trajectory and career choices etc. less acute and more favourable to interdisciplinarity. These pragmatic

realities conceivably feed back to the institution and sector in a way that reduces the visibility, and professional appeal of doing, interdisciplinary research.

The upshot is that there is an opportunity for the University to move to a more mature engagement with interdisciplinarity, helping shift the Academy's focus away from an agnostic zero-sum focus on whether "it" is being "done" or not, or how many heads are involved, to a greater appreciation of its diverse but patterned forms, what interdisciplinarity involves, and cultivation of not just disparate projects but the organisational and career context in which they exist. Through deeper engagement with the qualitative aspects of interdisciplinarity and with the practical, political and philosophical issues involved (of the sort flagged in this report), the University could become a leader in developing a more sophisticated, transparent, durable and inclusive approach to interdisciplinarity, improving our understanding of the world at multiple levels.

1 Introduction

Collaborative interdisciplinary research is increasingly supported as a multipurpose response to a range of academic problems and opportunities: intellectual, institutional and societal. While interdisciplinary research continues to spread throughout the Academy, research into its drivers, intentions and effects is not keeping pace. Empirical research into individuals' experiences and perceptions of doing interdisciplinary research in the context of other shifting conditions is needed to understand the potential and challenges interdisciplinarity poses. This document reports on a study at The University of Melbourne that has taken such an approach. It details some of the practical, political and philosophical issues raised by interdisciplinary research at the levels of the individual, project, University and Academy. Itself representing a cross-disciplinary project, it argues that collaborative interdisciplinary research is highly valued by those involved and deserves ongoing support. This includes recognition of the way that existing organisational factors, including the dominance of a somewhat exclusionary understanding of interdisciplinarity, increases the risk posed by interdisciplinary research to those involved by obscuring and amplifying the intellectual, interpersonal and management challenges such research often involves.

2 Interdisciplinarity

2.1 Interdisciplinarity in contemporary academia

Interdisciplinarity is a slippery research object that requires we focus on multiple groups and phenomenon above and beyond the disciplines that the term forefronts. It requires that we consider the sector, the organisations, the individuals and project groups involved. It entices us to trace not only the interconnectedness and mobility of problems and knowledge, but actors, identities, relationships, norms and resources. Interdisciplinarity demands that we reflect on the academic and societal context from which it has emerged, within with it is practiced, and that it is helping to remake.

2.1.1 Three agendas

One of the most striking things about the contemporary academic context and research policy is its multiple agendas. There are three intersecting agendas - or what institutional theorists would call "institutional logics" - in play. First is the overarching productivity agenda that is pushing for quantum increases in research. Despite being squeezed by swelling teaching demands and requests to engage with community, industry and government, research is increasingly prioritised as a privileged performance indicator in academics' job descriptions. Publication counts are widely used as a coarse but influential signal of a researchers' worth. Interdisciplinary and collaborative research is valued in this light as a means of accelerating research outputs, growing an indi-

vidual's and organisation's "institutional capital" relative to competitors[1]. Such an approach reflects the effects of the economic rationalism that is cutting public funding to universities in an effort to embed academia in the market economy, business ideals in academia, and academic research in business[2]. Individual universities are encouraged to negotiate the competing demands upon them in a way that not only helps to uphold their shared weakened sector, and its still-cherished academic values, but that improves their position relative to their competitors in Australia and abroad, against whom their performance is now repeatedly ranked (Billot 2010). As Jenny Lewis notes, the power of rankings 'is felt everywhere' and 'is a game universities want to win' (Lewis 2013, p.1).

Contributing to the air of competition is the second agenda at work in academia. More qualitative, the 'excellence agenda' is explicitly about high quality research. While rankings are one-dimensional, quality has conventionally been a disciplinary-specific question, being regulated by the traditional discipline-based academic structure. Nevertheless, interdisciplinary research is also valued in the excellence agenda to the extent it offers more innovative, ground-breaking, self-critical research. By opening up areas of inquiry to critique and assistance from those beyond the disciplinary fence, it is hoped further and better knowledge will be attained.

Border crossing is especially encouraged by the third agenda. Known simply as the "impact agenda", this newest development brings the political tussles of the outside world into the halls of academia. Dominated by industry and their government representatives, the disparate collection of parties keen to gain some academic "impact" include community groups, NGOs and the public at large (who are increasingly conceived as a target group). Academic research is now called upon to be not only excellent and prolific, but relevant (salient, timely, useable and generally impactful) and legitimate (respectful of others' views). These last two criteria reflect the long list of pressing real-world problems that new knowledge is needed on, as well as the democratisation (and related digitisation) of knowledges utilised in seeking solutions to them. Because relevance and legitimacy are of course dynamic and contestable criteria, the impact agenda has helped spark highly divergent visions of public good (Marginson 2011).

Regardless of which social goals or academic agendas individuals or organisations prioritise (or resist), interdisciplinary collaboration is increasingly celebrated as the means to the end, or even an end in itself. The ambiguity of interdisciplinarity means that it can draw together enthusiasts (including funders and researchers) at the same time as they diverge in exactly what they think interdisciplinarity is or seek from it. Others may bond over a shared dislike of the idea of interdisciplinarity, while differing widely in which aspect of it they question or which academic trend they associate it (e.g. research that is over-or under-focused on society). Reflective of the infinite array of new knowledge and issues it can be directed towards, interdisciplinary research is equally at home within strongly progressive or conservative visions of the future, including the future of academia.

The above means that interdisciplinarity is a highly varied not unitary phenomenon (Cooper 2013). Con-

[1] In this frame, capital refers not only to money *per se* (though generating financial capital is increasingly important) but to any "resource" or "asset" that confers advantage and allows for comparison between types.

[2] See for example the recent federal government report 'Boosting the Commercial Returns from Research' report that strongly prioritises university engagement with industry in order to increase business profits. http://www.dpmc.gov.au/publications/Industry_Innovation_and_Competitiveness_Agenda/docs/indust

tributing to this is the fact that government agendas - as diverse as the may be - are not the only drivers of interdisciplinarity. As Barry and Born (2013) emphasise, interdisciplinarity 'cannot be understood merely as instrumental or as a response to broader political demands, social or economic transformations' (p.4). They warn against not only the temptation of over-stating how novel interdisciplinarity is, but the temptation to read its contemporary rise in an overly political and teleological manner. In keeping with this, it was apparent in the first MICE report that for some researchers interdisciplinarity is an emergent, unintended effect of following their passions across disciplinary (and academic) boundaries, or as a way of working with colleagues whose company they enjoy. That an individual may now recognise and conceive of their creativity-led research] as interdisciplinary points to the way that "interdisciplinarity" is now a shared conceptual object in the Academy, a new coordinate by which academics of all types (interdisciplinary or not) understand and position their work. Combined with the rising literature on interdisciplinarity *per se*, 'interdisciplinarity has come to be at once a governmental demand, a reflexive orientation within the academy, and an object of knowledge' (Barry et al. 2008, p.4).

2.1.2 Conceiving interdisciplinarity

Contributing to expanding debates about interdisciplinarity is the question of how "natural" it is imagined to be. Some academics associate it positively with the less fragmented knowledge of the past, or with the more comprehensive, pluralistic knowledge anticipated of the future (Frodeman and Mitcham 2007). Others interpret interdisciplinarity as a needlessly forced, mechanical process disruptive of genuine scholarship in the disciplines (Frodeman 2011; Jacobs and Frickel 2009; Peterson 2009) and of unproven and questionable value in producing creativity 'on demand' (Hansson 1999; Ross 2009). Different stances towards interdisciplinarity reflect the extent to which people imagine disciplines to be already internally heterogeneous and/or effectively interdisciplinary, reflecting systemic differences in how different disciplines tend to conceive of disciplinarity (Krishnan 2009). Although interdisciplinary collaboration is often inhibited by existing discipline-based structures (Griffin et al. 2005; Kandiko and Blackmore 2008; Lowe and Phillipson 2009; Miller 2010; Rhoten and Parker 2004; Siedlok and Hibbert 2014), some commentators assert that interdisciplinary collaborative initiatives simply formalise (and potentially distort) academics' natural boundary-crossing knowledge-seeking behaviour of the sort common in some fields (Frodeman and Mitcham 2007; Hansson 1999; Pharo and Bridle 2011).

The question of how bounded and thus "real" disciplines are as entities rather than rhetorical labels signals a broader shift in view and practice. While disciplines have (from a sociological and anthropological perspective) been conventionally conceived as bounded "territories" and "tribes" (Becher 1989), there are now signs that disciplines are being practiced and/or imagined as more fluid and transitory (Tight 2014). This new condition and/or focus on flows of knowledge and flexibility in organisational structures has various roots. Among other factors these include: the rise of 'network governance' in society, positioning academic knowledge production as one activity among many (Lewis 2013; Pallett and Chilvers 2014); critiques of disciplines as inadequately responsive to shifting market demands (reflecting the adoption by university leaders of what Krishnan (2009) describes as a management studies view of disciplinarity); and the mainstreaming of complexity thinking of the sort that has brought the "wickedness" of social-environmental challenges to the fore (Head and Alford 2013).

In the dominant definition of interdisciplinary, the distinction between stability and fluidity represents not two conceptual lenses but two ends of a heuristic spectrum in knowledge production settings. At the stable end are imagined to be the strong borders of disciplinarity, where knowledge production is characterised by an internal focus, great depth and discipline-specific quality control. At the fluid end, in contrast, are imagined to be the unbounded practices of transdisciplinarity, where knowledge production crosses or even transcends multiple borders, including that between academia and society, and quality is assessed in a more pluralistic fashion. Interdisciplinarity is imagined as somewhere in between, a hybrid form slightly to the right of the relative rigidity and integration-lite imagined to characterise multidisciplinarity (Klein 2010). The "properly integrated" and flat internal structure of interdisciplinarity in this framework acts as both a drawcard and repellent, holding epistemic and/or political appeal for some (e.g. Jones and Macdonald 2007; Kostoff 2002; Reisinger 2011), but striking others as overly-abstract, epistemologically violent and politically naïve (e.g. Lynch et al. 2008; MacMynowski 2007; Mauthner and Doucet 2008).

The rapidly growing literature on interdisciplinarity is beginning to move past ongoing questions of definitions and purpose to explore the infinite empirical variation that exists among interdisciplinary collaborations in practice. Most prevalent in the literature are quantitative studies designed to identify the structural, demographic and behavioural correlates of strong interdisciplinary performance and desired outcomes such as high research productivity. In part this is because interdisciplinarity is seen as something of a proxy for how "impactful" academic research is or is predicted to be. In contrast to this quantitative approach is recognition that any collaborative interdisciplinary research project is a complex, context-specific and subjective process. This has led to more qualitative studies of interdisciplinary research as an embodied, inter-personal practice by unique individuals in particular professional settings. Case-based research on interdisciplinary collaboration has also been boosted by the argument that such detailed study is the only lens through which interdisciplinarity can be learnt (by participants or observers) (Krohn 2011). This interest in learning about interdisciplinarity reflects a broader shift from questions of "whether" to do interdisciplinarity to "how" to do it (Frodeman 2011; Jacobs and Frickel 2009).

Appreciating the influence of epistemology (our intellectual framework for determining what knowledge is valid) on our thinking is arguably a key task for anyone who engages in interdisciplinarity, especially that which brings together two or more epistemological traditions (referred to as 'radical interdisciplinarity'; Jacobs and Frickel 2009; Klein 2010; and a particular focus of this project). In society, the democratisation of knowledge is associated with the rising profile of an 'interpretivist' epistemology that recognises the partial, transient, multi-layered and contestable character of any one perspective and the validity of plural knowledges in general. Combined with the dominant positivist epistemology that primarily values interdisciplinarity as a route to more comprehensive knowledge, this shift towards interpretivism is another 'key epistemological impetus' for rising interest in interdisciplinary knowledge (Manathunga 2009). Both recognition of the validity of an interpretivist paradigm, and acceptance of its specific validation of multiple ways of knowing, encourages respect and conversation between different disciplines. Interdisciplinary exploration is celebrated in this light as a mechanism for critically examining established ways of knowing and for reconceptualisng issues in different ways (Manathunga 2009).

2.1.3 Framing research

Any given university (or government) selectively defines and shapes research in an ongoing and dynamic way. This "framing" of research is practical as well as rhetorical. It emerges not only out of explicit research policy statements, but out of organisational structures, administrative systems, expected practices, external media, stakeholder relationships cultivated, and culture encouraged (Brew and Boud 2009; Wenger 1998). Implicit and unintentional as much as explicit and intentional, this continual framing of what counts as valuable research reflects how a university is negotiating the broader interacting logics at work in the academic sector. It is experienced differently by individuals according to context-specific mediating factors such as the highly particular character of different organisational units and intersecting multi-vocal messages about other aspects of academic life such as teaching. For example, recent research at an Australian public university with a strong economic logic found that while a 'deep-seated antipathy to a market ethos that reduces higher education to a narrow economic function' was widespread among academics, an 'identity tension' between economic and academic value systems was felt especially acutely among those in science (Winter and O'Donohue 2012, p.565). Disciplinary and organisational location contribute to the assemblage of ideals, norms, structures and practices that dynamically frame or shape how individual academics enact their own professional values, identities and activities (Malcolm and Zukas 2009). Also of influence is others' perceptions and experiences of interdisciplinary research.

The project described in this report explores the practical, philosophical and political aspects of individual researchers' experiences with collaborative interdisciplinary research in order to deepen researchers' and managers' understanding about what is involved and what factors are in play. To do this, it considers interdisciplinary research projects in relation to various contextual factors, conceptually positioning interdisciplinary collaboration at the centre of the diagram below (Figure 1). It focuses upon individuals' perceptions and experiences of interdisciplinary collaboration because it is only through such individuals that such collaboration and its outcomes emerge. As Jenny Lewis argues: 'Individual academics' perspectives are crucial... Different academics will respond differently, and the same academics might react differently at different times' (p.20).

Researching interdisciplinarity requires some degree of interdisciplinarity itself. Drawing on literature from a wide range of disciplines, notably that on higher education, this study adopts a broadly critical interpretivist approach, reflecting the author's background in human geography and the fact that studying "collaborative interdisciplinary research" requires many of the tools of social science. It tries to balance the "three P's" of interdisciplinary research - practice, politics and philosophy - and to address the needs of a diverse potential audience. Readers are obviously welcome to skip over sections that are not to their disciplinary taste. Theoretical concepts are only introduced as needed. For those interested in more in-depth discussion of some of the key issues, a reading list is provided at the back.

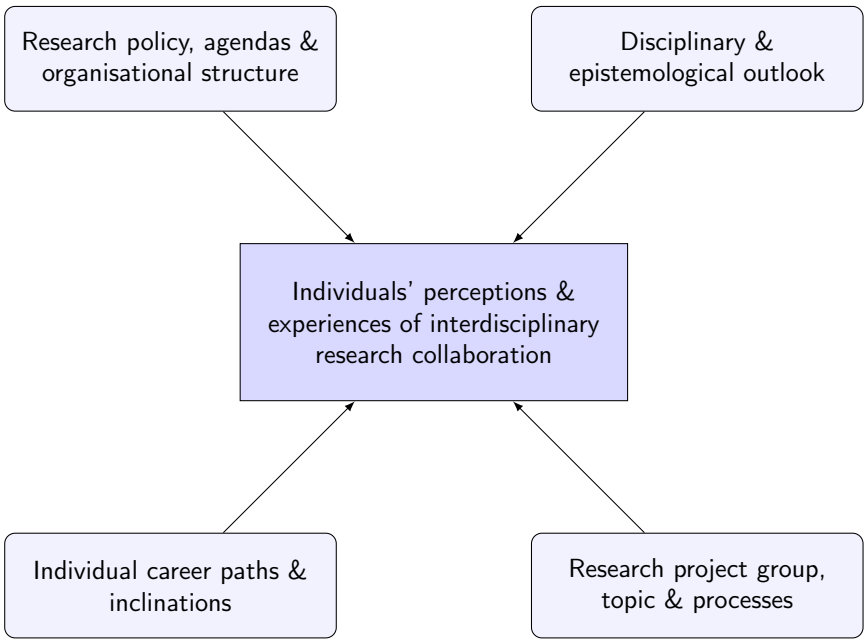


Figure 1: Schematic diagram of the main factors of interest in this project

2.2 Interdisciplinarity at The University of Melbourne

At The University of Melbourne, organisational engagement with the topic of interdisciplinarity is on the rise. A highly ambitious organization, the University expresses its mission through the metaphor of the triple helix: three tightly interwoven strands consisting of research, learning and teaching, and engagement. All three strands demonstrate the rising influence of interdisciplinarity, as does their interweaving itself.

The concept of interdisciplinarity is implicit within discussions of the University's future research portfolio. As the recent Growing Esteem 2014 document states plainly, the organisation is working to lift its research impact. It is pursuing this by focusing its research efforts more sharply upon three nominated Grand Challenges: understanding our place and purpose; fostering health and wellbeing; and supporting sustainability and resilience. As used elsewhere (e.g. Bestelmeyer and Briske 2012; Lyall and Fletcher 2013; Reid et al. 2010), this Grand Challenges framework embeds within it a prioritisation of interdisciplinary research collaboration. Combined with more recent government efforts to focus academia more intently on generating benefits for the private sector, the research direction of the University as a whole is gently tilting towards interdisciplinarity. Nevertheless, the established disciplinary structure and culture of the organisation presents a substantial counterweight. Pushing in both directions is the commitment to invest in any research area 'that can demonstrate a world-leading position' (p.12).

Formal encouragement for interdisciplinary collaboration and impactful research at the University began with the establishment of the organisation's now five research institutes[3]. Mostly virtual (although part of a biomedical research precinct in the case of Bio21), these are tasked with the job of fostering research around certain broad themes. Leanly operated, they represent a relatively light organisational overlay across the disciplinary-based faculty structure. Their role is to generally facilitate not fund research and the vast majority of researchers who engage with them do so in a voluntary capacity from a faculty base. More recently, the University has established two other similarly interdisciplinary and somewhat more concrete units: Carlton Connect and the Melbourne School of Government.

Flexibility and experimentation are positively associated with organisational learning and adaptation of the sort demanded by the current academic and societal environment (Cornell 2010; Kellert 2009; König et al. 2013; Nissani 1997; Lyall et al. 2013; Lyall and Fletcher 2013; Rhoten et al. 2009). This includes flexibility and experimentation in approaches to addressing the Grand Challenges and fostering interdisciplinary collaboration. The University has pursued this idea through the use of an Interdisciplinary Seed Grant (ISG) program designed to distribute small-medium seed grants (approximately $20 - 50,000) to fund innovative interdisciplinary research projects for 12 months. Funded primarily by Melbourne Research and administered through the virtual institutes, the program was formally concluded in 2013 after four funding rounds, in part to make way for a next generation of initiatives (though some research institutes continue to fund their own ISG-like scheme)[4]. Over the four years of the project, 545 individuals were involved (456 from The University of Melbourne), with 438 involved in one project, 76 in 2 projects, 16 in 3 projects and 15 in 4 or more.

The ISG program not only provided a catalyst for interdisciplinary research in the University, but provides a valuable empirical window onto it. As a research filter, it represents a sample of highly diverse, partially self-selected, partially institute-selected research groups, centred on the institute themes and an open interpretation of interdisciplinarity.

Given that the role of interdisciplinarity is on the rise in the University - including through ongoing internal interdisciplinary research funding from Melbourne Research Office, Melbourne School of Government and Carlton Connect - it is timely to look through the empirical window of the ISG program and consider what we can learn about interdisciplinarity in practice in the University. Doing so offers potential insights into how the University may negotiate the twin agendas of research excellence and impact and how its manoeuvres to date are influencing academics' practices and identity.

[3]The institutes and their thematic foci are listed in Appendix A. Over the time frame of this project, the Materials Institute has been discontinued and the Social Equity Institute has been established.

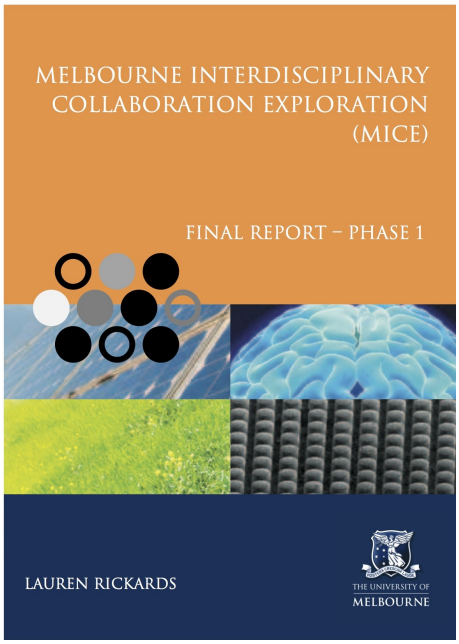
[4]Some institutes contributed their own funds to increase the amount of research funded in their area. The previous MICE report provides detail about how the program was conducted. See: Rickards, L. (2012) Melbourne Interdisciplinary Collaboration Exploration. Melbourne Research Office, The University of Melbourne http://ri.unimelb.edu.au/docs/mice-2012.pdf

3 The MICE project

3.1 Aim and overview

The aim of the MICE project is to gain a contextualised understanding of individual academics' perceptions and experiences of interdisciplinary research. Through the lens of the ISG projects, it explores participants' views of the process, outcomes and context.

Instigated in 2010, the project was designed to take advantage of the research opportunity afforded by the ISG program, provide feedback to University management about interdisciplinarity and to help address the relative deficit of detailed empirical work on interdisciplinarity in the academic literature. In 2012 a comprehensive report presented the findings from the first phase of survey and interview-based research with program participants. The current report presents findings from Phase 2.



3.2 Methodology

This project uses a longitudinal, mixed method approach to accessing researchers involved in the ISG program. A series of online surveys (closed and open questions) and interviews (semi-structured, 30-60 minutes, in-person, transcribed and coded) was conducted in 2010 - 2014 (Table 1).

This report complements that produced in 2012, presenting the findings from the final phase of research conducted 2013 - 2014, during a period of substantial organisational change. The 15 researcher interviews conducted during this phase consisted of a mix of 10 volunteers from the survey and 5 additional researchers from the HASS (Humanities and Social Sciences) disciplines. The latter sample was taken from a list of researchers involved in at least 3 ISG projects in order to gain insight into a range of ISG projects. The HASS focus was in response to the finding in the first report (and by others such as Gardner (2013)) that researchers from such disciplines may face particular challenges in interdisciplinary collaborations. The survey during this phase consisted of a subset of 10 of the original 18 questions used in earlier surveys to help focus on key topics. Hence, to some degree this report covers a different range of issues to the 2012 one, and readers are encouraged to read the latter as a complement to this one.

Table 1: Types and details of methods used in the MICE project

Method	Description	Objective	Sample	Actual sample	Timing
Surveys	In depth online surveys to collect a mix of qualitative and quantitative data	To gain broad input from researchers about their experiences and perceptions with CIDR at the end of all projects and to explore how this changed over the duration of the project.	All projects - R1: 95 researchers - R2: 119 researchers - R3: 166 researchers - R4: 191 researchers	Response rate - R1: 36 respondents (38%) - R2a: 37 respondents (32%) (start of project) - R2b: 28 respondents (24%) (end of project) - R3: 29 respondents (17%) - R4: 46 respondents (24%)	- Dec 2010 - Dec 2010 - Dec 2011 - July 2013 - Nov 2013
Interviews	30-60 minutes in person, semi structured, recorded and transcribed	To complement survey with more in-depth information from researchers	Willing project groups or individual researches associated with R1 projects that were identified by the researchers or directors as 'successful' in some way	- 7 institute directors, - 8 individual researchers, - 4 group interviews	- Nov 2010 - Mar 2011
			The interviewees are HASS researchers selected either as a researcher who has been involved in multiple ISG projects (from R1 – R4) or alternatively volunteered their personal details in either the R3 or R4 end of project survey	- 15 individual researchers	- Feb - May 2014

4 Results and discussion

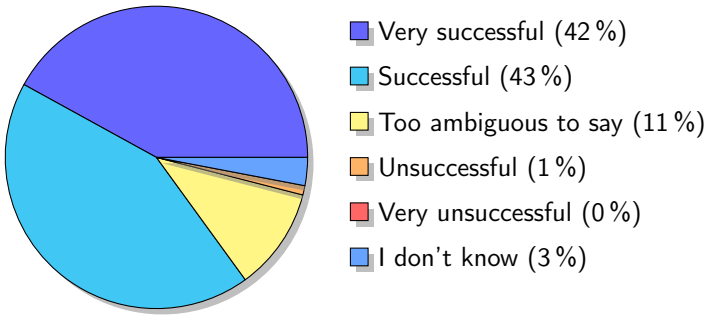
4.1 Outcomes and opportunities

4.1.1 Generating outcomes, generating capital

The vast majority of respondents were overwhelmingly positive about their project experiences, the significant difficulties many encountered notwithstanding. 85% ranked their projects as "successful" or "very successful", with a further 11% judging that it was too ambiguous to say and only 1% (one respondent) judging their project to have been "unsuccessful" (Figure 2).

Spanning a spectrum of tangibility, a wide range of project outcomes were reported[5]. Most common was some form of publication, with 94% respondents listing one or more such outputs (from books to draft papers). This suggests that, as expected, such outputs are seen as key academic currency, being prioritised in both project work and subsequent representations of it. Some respondents noted that their publications were in high impact journals. Approximately half of respondents mentioned making grant submissions and pursuing other funding opportunities, with ten out of 75 indicating that at the time of the survey they had already used their ISG grant to win further funding, including large ARC and NHMRC grants. Many more indicated that they hoped to follow suit.

Figure 2: Overall, to what extent do you feel the project has been a success? (N=72)



Virtually all respondents also described the outcomes of their ISG projects in terms of collaboration, ranging from new formalised partnerships, students, distance contacts and close friendships. The emotional or personal

[5]Note that the consistency of this positivity could be influenced by (a) self-selection bias in the sample towards those individuals positively inclined towards their projects; and/or (b) individuals interpreting the question "What outcomes have emerged from your project?" and survey in general as an academic reporting exercise of the sort that is now normal under the impact agenda, leading them to talk up/justify their experiences; and/or (c) individuals viewing the survey as an opportunity to communicate the value of the ISG scheme to university leaders.

benefit of finding like-minded others was also mentioned by a number of interviewees as a key benefit from their project, in keeping with the previous MICE report and findings elsewhere (e.g. Garbett and Tynan 2010; Goodman-Delahunty and Walker 2010; Tynan and Garbett 2007).

The question of how individual academics benefit from the various outcomes can be considered in terms of the different types of "capital" they offer individuals (to adopt the sort of economistic lens common in university management). Pertinent types of capital include:

- social capital: both in terms of 'bonding social capital' (people's strong ties, or close relationships with other people); and 'bridging social capital' (knowledge of and contact with others)[6]
- intellectual capital (one's skills, knowledge and understanding)[7]
- emotional capital (one's motivation, sense of wellbeing and emotional investment in one's work and workplace)[8] and
- institutional capital (one's professional standing in the University and academia more generally)[9].

This list is not exhaustive, the types of capital overlap and interact, and their suggested relationship to project outcomes is subjective. Nevertheless, the distinctions do help to capture the range of professional and personal benefits the project outcomes represent at the level of the individual. In other words, they help to understand why these outcomes are identified and offered up as signs of project success.

[6]Social capital is an enormous area of study in its own right, often traced back to Granovetter, M S 1973 The strength of weak ties. American Journal of Sociology 78 1360-80. Useful overviews include: Bartkus, V O & Davis, J H 2010 Social capital: Reaching out, reaching in Edward Elgar Publishing, Castle, E N 2002 Social Capital: An Interdisciplinary Concept*. Rural Sociology 67 331-49.

[7]Institutional capital is the most literally 'capitalised' of the types of capital mentioned here (that is, commodified and embedded within the "knowledge economy"). Indeed, so valuable is intellectual capital as a form of currency that it is now the topic of a proposed new academic discipline: Serenko, A & Bontis, N 2013 Investigating the current state and impact of the intellectual capital academic discipline. Journal of Intellectual Capital 14 476-500. In this report, intellectual capital includes not just tangible, transferrable knowledge but embodied and tacit knowledge such as how to perform a certain research task, how to manage a budget, or organizational "rules of the game".

[8]Work on emotional capital stemmed from (critical) interest in the 'emotional labour' required of modern workers (e.g. adopting certain dispositions) in the Capitalist economy given its focus on the productive value of emotional intelligence and effective interpersonal relations (see for example James, N 1989 Emotional labour: skill and work in the social regulation of feelings. The Sociological Review 37 15-42, Illouz, E 2013 Cold intimacies: The making of emotional capitalism John Wiley & Sons.) A less instrumental view focuses on academics' and others' emotional wellbeing as an ethical imperative. This has been motivated in some cases by concern about low levels of wellbeing – see for example Gill, R 2013 17 Breaking the silence. Secrecy and Silence in the Research Process: Feminist Reflections 228.

[9] Institutional capital is the most literally 'capitalised' of the types of capital mentioned here (that is, commodified and embedded within the "knowledge economy"). Indeed, so valuable is intellectual capital as a form of currency that it is now the topic of a proposed new academic discipline: Serenko, A & Bontis, N 2013 Investigating the current state and impact of the intellectual capital academic discipline. Journal of Intellectual Capital 14 476-500. In this report, intellectual capital includes not just tangible, transferrable knowledge but embodied and tacit knowledge such as how to perform a certain research task, how to manage a budget, or organizational "rules of the game".

[10]While all of the outcomes arguably generate intellectual capital (e.g. the know-how of managing a new research partnership) for the sake of simplicity only those outcomes that involve the generation of new "research based" knowledge are listed as generating intellectual capital. Similarly, while all of the outcomes likely contribute to individuals' wellbeing, the term emotional capital is used specifically to capture the personal benefit of some of the intangible outcomes listed such as a boost to one's self-esteem.

Table 2: Project outcomes reported and the main type of "capital" they may represent for individuals[10]

Type of outcome reported	Type of capital
Academic publications (papers, books) - Draft/Under review - Published	Intellectual capital (social capital if co-authored well) Institutional & intellectual capital
Further grant funding (e.g. ARC, gov. dept.)	Financial & institutional capital
Grant application	Institutional, intellectual & social capital
New research partnership (funder)	Financial, social & institutional capital
Patent	Institutional & financial capital
Conference papers/posters	Institutional & intellectual capital
Public report/inquiry submission	Social capital (bridging)
Public engagement & dissemination	Social & institutional capital
Improvements for research participants	Social & institutional capital
Team of postgraduates/students	Institutional, intellectual & social capital
New postgraduate supervision opportunities	Institutional, intellectual & social capital
New data (e.g. proof of concept trial)	Intellectual capital
New equipment/facilities	Intellectual & institutional capital
Professional development of own staff	Social & institutional capital
Visits/exchanges to other institutions	Social, intellectual & institutional capital
Invited presentations	Social, intellectual & institutional capital
Precedent for sharing samples/data	Social & intellectual capital
New inter-personal networks/contacts	Social capital (bridging)
New collegial relationships/friends	Social capital (bonding) & emotional capital
Proof of capacity to collaborate	Social capital & institutional capital
New research ideas and plans	Intellectual & social capital
New content knowledge/understanding	Intellectual capital
New research skills/wisdom	Intellectual capital
Increased visibility & sense of esteem	Emotional & institutional capital
Inspiration and motivation	Emotional & intellectual capital

Many of the outcomes listed above can take considerable time to emerge. Respondents' primary frustration about project outcomes was that they were simply too slow relative to the desired pace of progress. The longer the time frame, the more project outcomes blend into the broader context. As they do, they potentially grow in influence. Putting to one side the difficulty of tracing attribution (an issue that continues to trouble the impact agenda to the extent that impact is defined as more than intentions), we can imagine projects sending ripples across the parallel planes of ideas, relationships and organisations. Fragmenting, stretching and intersecting in complex ways, outcomes scatter across these planes, helping weave the boundaries of the project into its context. Interviewees described for example:

- beginning to work with one or more new collaborators met as a result of the initial research (expanding the collaboration network)
- "returning" to one's home discipline to work on a conceptual insight generated by the interdisciplinary research; and
- continuing to utilise and develop a method or skill developed in the initial project.

Another interviewee described the diverse paths that had opened up via her ISG project:

> *I think part of the interesting thing about these projects is they spin off, you know. They have these extraordinary spin offs! [Our project] is not... a project where you get a book ... It's actually a much more enlivened kind of outcome than that, you know. So I mean, yes we've got papers, yes we've got an ARC application, all of those research outcomes. But the more interesting thing is that then this project builds up again to become another meta-program, which is more fully formed 'cause the partners have done that work with you - they've seen an outcome at project level. So then you've got a meta-program that's spinning off other university outcomes like teaching, like new research partnerships, like new research questions... But the thing about those is they're longer term, you know. So when you seed something... if it's really significant, you're not going to see the benefit in the next twelve months. The seeding is going to be part of the laying the fertility around the whole program. And then once you've got fertile ground then that's when you really start to build something significant...*

Literature on the evolution of interdisciplinary research emphasises that the 'something significant' can become a new research field, such as the new 'interdisciplinary science' of 'Metallomics' (Sperling and Karst 2013), the new interdisciplinary social science of 'Public Deliberation in Health Policy and Bioethics' (Abelson et al. 2013) or the potential 'interdiscipline' of 'Interdisciplinary Collaboration' itself (Derry et al. 2013). At a more organisational level, an interdisciplinary interest may be formalised into a new initiative such as a centre or institute that promises to increase the scale, profile and efficiency of the interdisciplinary research involved (Kessel et al. 2003; Sa 2008). In both cases, new boundaries are created as existing ones are successfully or unsuccessfully traversed, opening up further collaboration challenges and opportunities.

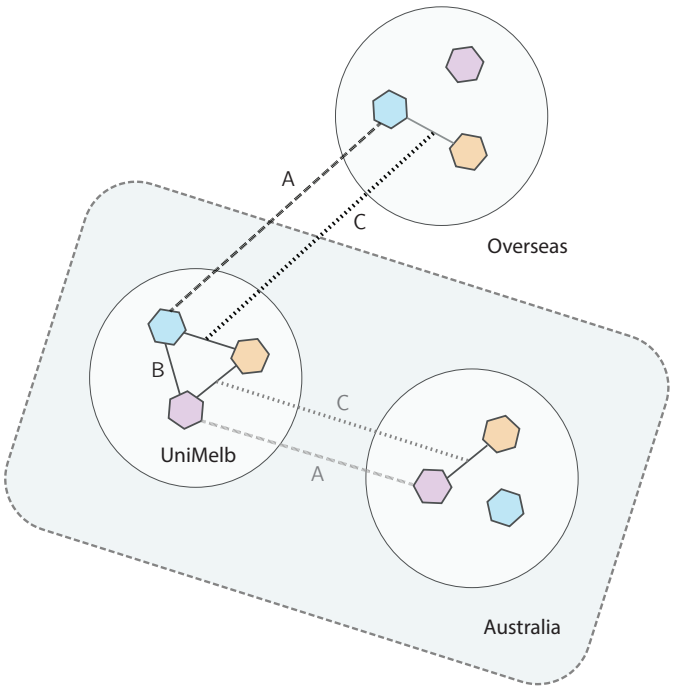
Finally, in thinking about the desired outcomes of interdisciplinary research it is important to note that from a funding incentive point of view the other major priority of the University appears to be international collaboration, in keeping with the globalisation of academia and rise of network governance. Thus, one of the things that gives the program that the interviewee above refers to its 'meta' character, is that it involves institutions overseas. The twin priorities of collaborating with other disciplines and institutions overseas necessarily de-emphasises other options: the option of collaborating with one's disciplinary colleagues, as is much debated in the literature on interdisciplinarity; and the far less discussed but arguably equally threatened option of collaborating with colleagues in other Australian institutions, who are also cast as competitors in the newly intensified environment of national competitiveness and inadequate funding. As mentioned above, the government seems willing to fund some large interdisciplinary cross-institutional centres (perhaps to help attenuate the institutional competition it is fuelling and to focus academics on its interpretation of the national interest). But there is arguably more interest at the government and University level in Australian (Melbourne University) academics participating in international interdisciplinary collaborations (of the sort funded generously by the European Union, for example).

This push to become internationally active reflects the ongoing globalization of the knowledge economy, an increasingly global impact agenda (e.g. an emphasis on "grand challenges" such as climate change or "Third World" diseases such as Ebola), the explicit internationalism of the excellence agenda (via rankings for example), a desire to expand beyond Anglo-centric research networks and opportunities, and normalised expectations about academic mobility[11] (Jacob and Meek 2013; Sergi et al. 2014). Thus the ultimate outcome of interdisciplinary collaboration envisaged at Melbourne is likely a strong role for the University in cutting edge, globally important and well-funded international interdisciplinary research, merging the impact and excellence agendas and pushing up its ranking and prestige relative to domestic counterparts (Figure 3). It is in the context of this faintly articulated ambition that academics undertake their small ISG projects.

4.1.2 Perceived opportunities

The strategic ambition sketched out above is likely second nature to academics and helps explain the growing appeal or logic of investing in interdisciplinary research in general. But what is it that drew academics to the ISG scheme in particular? What specific sense of opportunity stimulated them at the time? All collaborative research projects rest upon the three legs of ideas, people and resources. The extent to which any one precipitates a research project varies by situation and preference. Across the diversity of circumstances and motivations described by respondents, a common feature was the highly strategic attitude many had towards the projects, indicating that they value the projects as an opportunity to prove (or test) their research ideas, their collaborations and/or their funding capacity. Many respondents represented the projects as a means to

[11] On some of these trends see Sergi, B, Parker, R & Zuckerman, B 2014 Support for international collaboration in research: The role of the overseas offices of basic science funders. Review of Policy Research 31 430-53. Jacob, M & Meek, V L 2013 Scientific mobility and international research networks: trends and policy tools for promoting research excellence and capacity building. Studies in Higher Education 38 331-44. Larner, W 2014 Globalising knowledge networks: Universities, diaspora strategies, and academic intermediaries. Geoforum.



A – Disciplinary cross-institutional collaborations
B – Interdisciplinary collaboration within Melbourne University
C – Interdisciplinary cross-institutional collaborations within and beyond Australia

Figure 3: Collaboration map

help build their "track record", reflecting the instrumental, risk-averse, asset-based lens through which they themselves are often assessed in the meritorious academic environment.

Approximately two thirds of survey respondents reported that the ISG funding was 'extremely important' to the formation of their project group. While this is good news for the ISG scheme, underlining its catalytic effect, interviewees also warned of the dangers of being too strongly funding driven. Projects constructed solely in response to the funding opportunity can prove fatally unstable. Two interviewees described their experiences of disjointed groups of people coming together around a poorly articulated topic in the name of carrying out a research grant most had little to do in writing. Unsurprisingly, both stories end badly.

In contrast, the ISG grants seem exceedingly effective when they 'seed' into at least partially prepared ground (to use the metaphor introduced by the interviewee quote above). For, as research into "windows of opportunity" for social or policy change suggests, opportunities only exist as such for those ready to take them

up[12]. As found in the first MICE report, the projects described by respondents varied in the extent to which ideas or groups were pre-formed at the time of the grant call. Deficiencies in either the topic or team pose an existential threat to projects. Reflecting prior experience and preferences, respondents varied in which of the two they prioritised.

On the one hand, a number of interviewees prioritised the importance of getting the group right, underlining that they have learnt to be very careful about who they work with. Such care is perhaps especially important and difficult in the case of interdisciplinary research, where more professional differences are likely to be in play (as discussed below). In recognition that the ARC and other large granting bodies seem to favour tried and tested collaborations, a number of respondents commented that the ISG grants offered a chance to build collaboration credibility. More importantly, they offer a chance to test collaborations and help determine who an individual wants to share their research track with. As found in the first MICE report, collaborative interdisciplinary research was described by academics as relationship-intensive, requiring great patience and trust on the part of those involved and making choice of collaborators a critical factor. Numerous interviewees emphasised how selective they are in who they work with on such research.

On the other hand, some interviewees recounted difficulties with poorly formulated topics. Some described untargeted projects initiated by a pre-existing group seeking a shared project, leading to *'nebulous discussions where everyone was like "Wouldn't it be lovely if we worked together"...'*. One young academic with a very clear sense of the need to build a consistent track record for ARC grants was strongly of the opinion that projects should instead be topic-led:

> *[The ISG] scheme is really good for a number of reasons, but at the same time it is a way to fund research that you're interested in and you want to develop, not necessarily because you want to set up collaborations. I don't think you do it for that reason: you don't do it because you want to collaborate, you do it because this research is interesting, you want to develop it. And the fact that it's easier to get some funds to support that by collaborating, you know, that's part of the reason why you go down that track... Otherwise its sort of shorter term stuff - interesting to collaborate on a paper or two but it's not going to completely change the direction of your research.*

Such a strong research focus and strategic use of collaborative research funding is arguably ideal academic behaviour. The University actively encourages an instrumentalist attitude and future orientation towards the ISG scheme by specifying that they are to be used to support future grant applications.

Survey results suggest that the vast majority of respondents anticipate some degree of continuity around their project. 92% reported they expected to keep working with at least some members of their project group, with 83% of survey respondents reported that over the long term they expected to keep working on the

[12] John Kingdon first developed the idea of 'windows of opportunity' for policy change Kingdon, J W 1984 Agendas, Alternatives, and Public Policies Little, Brown, Boston. It has since been applied in a vast range of sectors where change is sought (e.g. McSweeney, K & Coomes, O T 2011 Climate-related disaster opens a window of opportunity for rural poor in northeastern Honduras. Proceedings of the National Academy of Sciences 108 5203-08.)

Q1: Do you expect to work on your ISG project topic in the long term? (N = 72)
Q2: Do you expect to work with any of your ISG team members in the longer term? (N = 72)

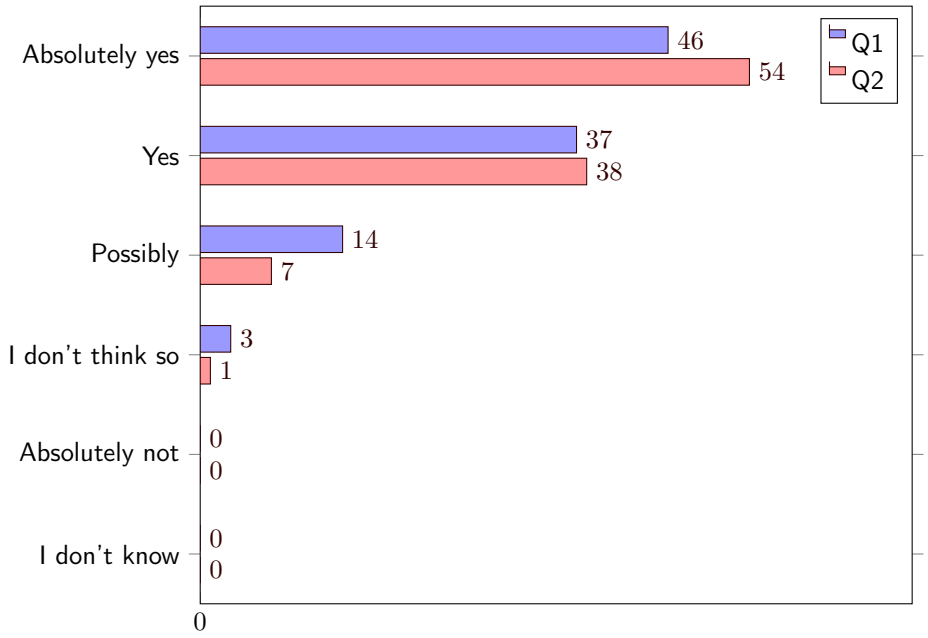


Figure 4: Survey results from R3 and R4 surveys (%)

project's research topic (Figure 4). Qualitative responses indicated that even as some aspects of the research collaboration alter – from funding running out to teams changing – researchers tend to look for and value stability in other elements:

> *This project has been successful in fostering long-term collaboration with colleagues, although progress on the project has been slow. It is good to see that even after the funding is finished, we still continue working on the project for the future grant application.*

> *I have eventually been successful in securing ARC funding for a larger project, albeit with a largely different research team, but which now includes a future partner.*

The value many respondents placed on some degree of continuance suggests that individuals will cultivate the intellectual and social capital seeded by the projects. If their institutional capital grows as a result, and their influence in the University and Academy continues to extend, this may include their commitment to interdisciplinarity, helping to slowly embed it as a norm around them.

Interdisciplinarity is already the norm for many in contract based applied research. Here, the ideal of continuity in topic and collaborators can be a dream. Research trajectories are rarely straight thanks to the "natural

variability" imposed by short-term competitive research funding and research contracts. As other authors have documented (e.g. Rhoten and Parker 2004), interdisciplinarity can pose a risk for early career academics or any other academics short on institutional capital, including those in marginalised (new) interdisciplinary fields (Griffin et al. 2005; Peterson 2009). This is partly because interdisciplinarity not only tends to be slower and less certain, but can represent and exacerbate a lack of control over career direction, thereby reducing an academics' ability to generate the markers of expertise that the still-dominant meritorious excellence agenda uses to bestow privileges such as job security. One young academic explained:

> *Most of the projects I've worked on have been interdisciplinary projects... And I have had advice about that from a boss who's had the same problem. Because... the type of work we do is... well, it tends to come out of perhaps opportunities or problems - problems that are presented to us. And so you go "Yes, I'll take on that problem and work on that project"... But you're coming up with a completely new project. You can't sort of say "Oh I can add this onto something I'm already doing"... So you can end up with a fairly scatty looking CV...*

Even if a researcher does achieve a degree of consistency and recognised expertise on a topic by stringing together a series of projects in the one area, if the funding is still project based and dependent on external funding, it - and thus the value of the researchers' expertise - is vulnerable to changes in policy and priorities (as climate change researchers around Australia have recently found). They are also vulnerable to missing out on new opportunities for interdisciplinary research on different topics to the extent such projects are put together (as they often are) on the basis of the disciplinary expertise individuals can offer the group and project optics (how readily the project topic and team seem to align according to outside observers such as research funders), rather than individuals' experience in interdisciplinarity *per se*. This suggests that there may be important differences in what interdisciplinarity means for individuals' careers according to whether individuals are interdisciplinary topic-based specialists or disciplinary-based interdisciplinary participants. The former may be further disadvantaged if they are relatively new to academia and their lack of disciplinary basis means they have smaller networks and a lower profile in the University than those in the disciplinary-based mainstream. Though this may not be the case, other literature suggests it can occur (Cantwell and Scevak 2010). Such disadvantages can be cumulative as it affects young academics' performance via its influence on their 'research confidence' (Archer 2008a; Archer 2008b; Hemmings 2011) and capacity to break into established research circles (Goring et al. 2014).

Even senior academics are vulnerable to policy shifts if they have invested strongly in an applied interdisciplinary research agenda and track record that then falls out of favour with industry or government research funders. As one explained:

> *The current State and Federal government just doesn't want to know [about the social problem she has been working on]. And it certainly doesn't want to be involved in a paradigm shift!... It's really hard to have a serious talk about addressing huge concerns... We're actually going backwards very, very rapidly... As I say, it's becoming harder and harder to get research money... So my interdisciplinarity has shifted somewhat... It's very stressful.*

In other words, current and future research funders are among those whose perception of one's interdisciplinary research can influence one's ongoing engagement with it. If research priorities change and an academic finds that their funding options evaporate, not only is their active engagement with the field of research stopped in its tracks, but their career outlook is dimmed as the slump in funding - and in their future funding *prospects* - counts against them in an ongoing manner if University priorities similarly shift. For while the impact and excellence agendas may differ in what they consider good research, under the productivity agenda they are aligned in a belief that what must be avoided is inactive researchers with empty budget accounts.

Sometimes researchers have to leave a project before the budget is extinguished, especially if it has only been paying for a small fraction of their time. Survey respondents described such dissonance as a constraint on their ISG project, stating:

> *Progress slow as original team are now split over a wide range of institutions with contracts ending and staff moving to other work sites.*

> *The results were interesting, but due to team members leaving the country the most interesting aspects could not be followed up on.*

We see here how the high academic mobility between institutions that is now the norm in academia (especially research) (Hoffman 2009; Larner 2014; Maadad and Tight 2014; Reisberg and Rumbley 2014) adds another uncertainty to collaborative research endeavours (McAlpine 2012; Seeber and Lepori 2014). Contract staff can be forced to move on due to many universities' preference for saving valuable tenure track positions for newcomers from outside (preferably someone from an institution higher up the rankings), just as others can be left high and dry as their colleagues leave for new opportunities. For institutions, attracting bright staff from elsewhere can bring instant kudos and contacts (Seeber and Lepori 2014). It also brings in fresh blood - that is, intellectual as well as social and institutional capital - in keeping with the logic of cross fertilisation inherent to interdisciplinary research, and entailing all of the same boundary-crossing challenges.

4.2 Driving the project

4.2.1 Research management

As we saw above, many researchers try to drive their projects along their own career tracks, throwing forth a trail of outcomes they can use to fuel their ongoing journey. Besides the issue of multiple or missing captains, discussed below, this challenge of harnessing a project to one's research path is a question of timing. To translate into maximum institutional capital, project-based research needs to be coordinated with the syncopated rhythm of further research opportunities. All researchers know that part of "doing research" is nurturing its succession, linking together the tasks of research production and reproduction. Even before the productive research cycle of a single project comes to a formal end, researchers need to step into the higher level "reproduction cycle" of research, characterised by decisions about priorities, grants and collaborators, with the hope of moving back down into internal "research production" mode if future opportunities come to fruition (Figure 5). A rhythm of research effort and outcomes is created as a project - usually one among many - flows into a grant applications; again usually one among many.

Respondents provided insights into their ongoing movement between the internal research challenges of their ISG project and helping to ensure it spawns further research opportunities. Comments in the survey frequently demonstrated a preoccupation with future funding:

> *We are a team of mostly early career researchers. This funding has provided the means to develop a strong and highly motivated team. We have been successful in collecting new and interesting data, submission of publications, and the attainment of two competitive grants for next year.*
>
> *This project is giving us the data we need for competitive grants.*
>
> *This is becoming my new are of research and future directions – depending on funding.*

Navigating a research project towards 'expansion and transformation' is one of the project management tasks that König et al. (2013) propose is required in interdisciplinary research. Noting that the majority of project management tasks are overlooked in discussion (and enactment) of interdisciplinary research - perhaps given people's focus on the intellectual or technical complexity involved - they highlight the need for interdisciplinary researchers to strike a balance between opening things up (decentralisation and differentiation) and closing things down (centralisation and integration), both intellectually and practically. They also highlight the need to balance an internal and external orientation of the sort discussed above in terms of research production and reproduction. The result is a proposed 'framework for interdisciplinary research management', based on Quinn's (1988) Competing Values Framework (Figure 6). It outlines four areas of project management and different roles that researchers, or at least the lead researcher, needs to play in each. In doing so, it captures a sense of the multiple identities researchers need to play in academic work and the tension between the three agendas at work in academia.

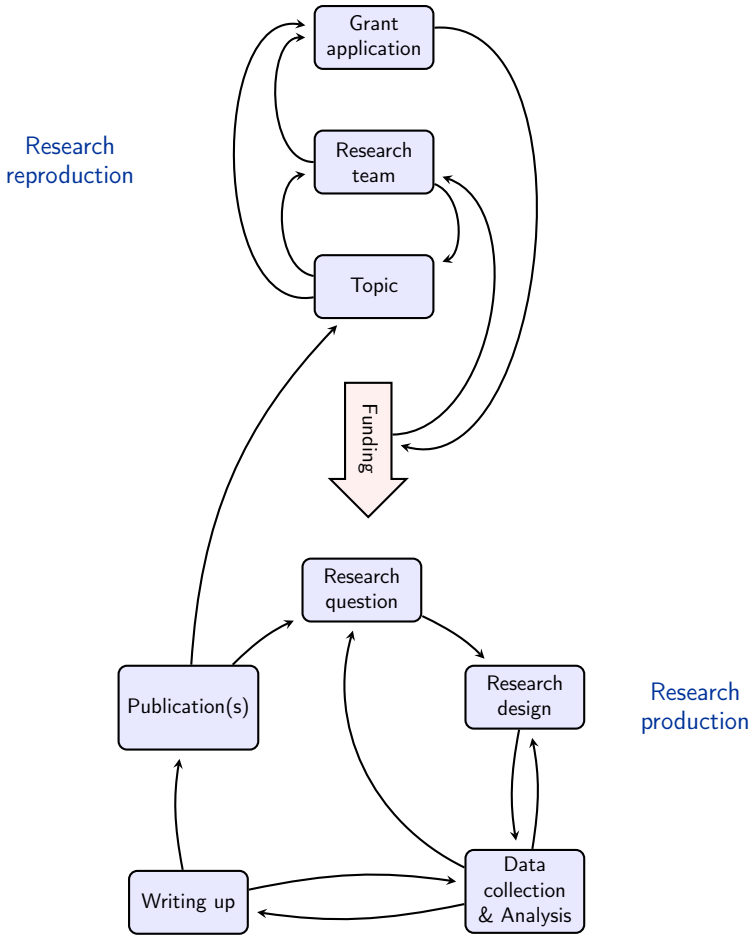


Figure 5: Schematic diagram of the main factors of interest in this project

In keeping with König et al.'s (2013) observation that the project management literature has rarely been discussed in relation to academic research, few researchers gave details about how they managed their projects. One who did described how the success of her ISG project group was due in part to her very strong 'task focus'. She acknowledged that while some people could find her approach blunt, prior experience had taught her it was necessary, especially on short grants with no time to waste. Others similarly emphasised that the openness idealised in interdisciplinary research needed to be accompanied by strident efforts to come to some sort of closure. Numerous respondents referred to the need for 'strong leadership', resonating with the kind of roles of producer, director, and coordinator mentioned in the figure below, and combining an intellectual and interpersonal role. Webber (2013) similarly blamed poor leadership on the struggles of many of the interdisciplinary projects he studied, with his 'fundamental conclusion' that 'any interdisciplinary research project relies in the first place on its leadership' (p.55).

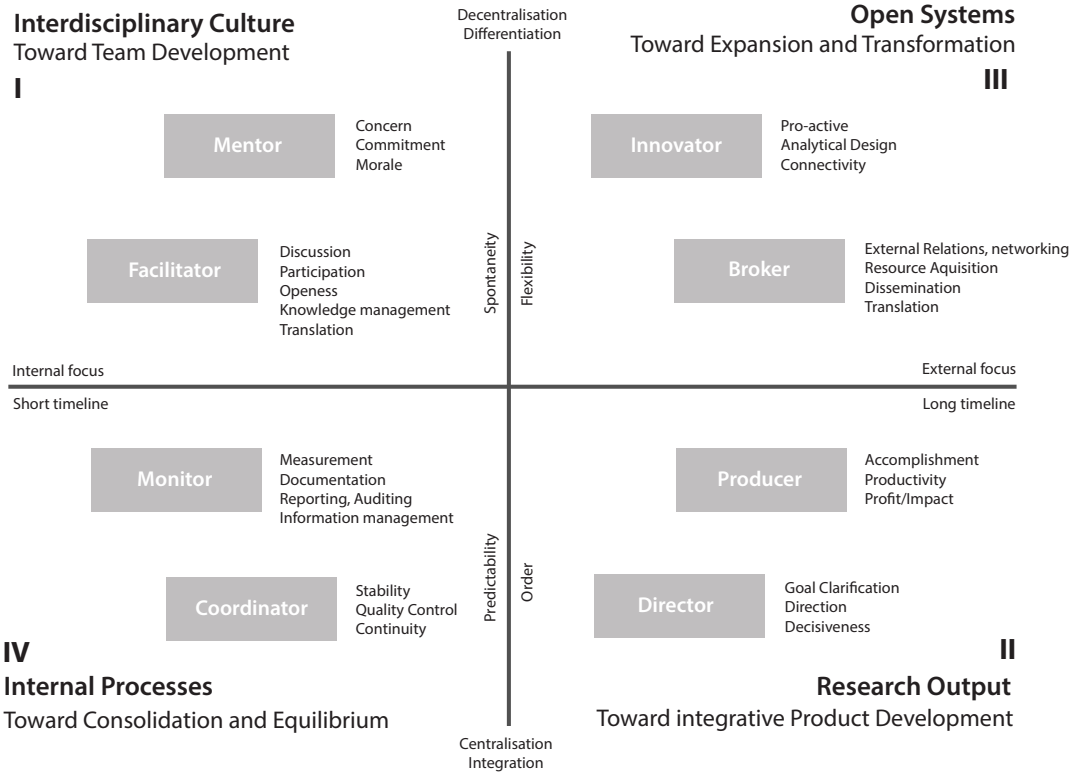


Figure 6: A framework for interdisciplinary research management (from König et al. 2013).

4.2.2 Project speed humps

Many respondents provided insight into the "speed bumps" their ISG projects had encountered (Table 3). As could be expected given the high levels of success and satisfaction reported about the projects[13], these challenges were successfully negotiated in most cases. One project, though, was described as being completely derailed. Its primary problem was the young research leader - a victim of his own success - ended up with more higher-status research commitments (successful ARC grants) than he had anticipated and chose (naturally) to prioritise them over the ISG project, illustrating again the need to see the ISG projects in the context of broader research funding cycles and goals. Recognising that he did not have time to run the ISG project - and that the rest of the group had little cohesion due to not having ever met - this researcher disbanded the project and returned the money. While such an experience was no doubt difficult, those involved as group

[13]It must be reiterated here that the sample represents voluntary participants and the researchers most disaffected with their experiences are likely not to have been captured.

members described his decision to discontinue as rational, courageous - and a relief to them. For in a sense this decision was an act of strong research leadership of the sort called for above (albeit too late), not to mention an appropriate prioritisation of opportunities from the greater University's perspective. The situation illustrates the challenge of attracting good (busy) researchers to small interdisciplinary projects in the context of growing pressure on researchers to be selective.

The problem of maintaining commitment and group cohesion was repeatedly mentioned as an issue. Some suggested that the small size of the ISG projects relative to many researchers' other concerns (research and other) exacerbated the problem, with one suggesting that no one above senior lecturer level should be allowed to be involved for this reason. The downside is that the strong and skilled project leadership that interdisciplinary projects require can be difficult to exercise by an early career researcher tasked with managing a disparate group of senior academics. This is especially and perhaps often the case when the researcher left to actually run with a project is not officially in charge. One young contract researcher in this position described the bottleneck that her project had struck because of the need for the lead Professor to negotiate with an external stakeholder, but being too busy to do so.

Such disengagement raises questions of willingness and capacity. One early career researcher commented that he felt most academics did interdisciplinary research as a 'side line':

> *I think it is more difficult to actually maintain interest in a multidisciplinary project because there is typically one person that is interested in a topic and it's their main area of research, they want to explore it. And often I think a lot of cases it's sort of a side line for a lot of other people.*

In contrast, a senior academic who admitted that he had 'dropped the ball' on his ISG project illustrates how the commitment issue is not necessarily a simple question of "choice". Describing a sense of disappointing everyone, he talked about the challenge of trying to create space in his professional and personal life for the interdisciplinary research such as the ISG project he wanted to work on:

> *So there's just an enormous resourcing issue about our capacity.... There's no question benefits are enormous and, you know, outputs are great if you generate them. But it's just getting there, and that's the negative. The negative is we're all so damn busy and we all lack capacity and we'd all like to go away for six months, twelve months and just take stock and regain some composure and sense of where our research is actually going, rather than being so responsive and reactive to the output demands or whatever it might be... You know, the reality is... the window we have is so small to actually take on new projects... Unless you have no children and you're prepared to sacrifice your time in a personal relationship... you know, it's kind of really tough... I mean I'm very keen to do more [interdisciplinary research] in the future... I just want to have time to do it properly so ... which is probably I think a validation of the concept rather than rejection of it. But it's just how do you create the proper space and time to do it?*

He continued that his primary concern for his ISG project was that the young researcher who had done the

'lion's share' of the work was adequately rewarded for it, which required him and rest of the group to ensure that the intended publications were actually produced.

A sense of being pulled in different directions also seems common among researchers from outside of academia. A number of survey respondents pointed to the particular challenge of maintaining the active involvement of external partners. While they expressed frustration about this, being forced to cope with 'far more limited results' than they would otherwise have generated, for example, the partners involved may not have wanted to be so uninvolved. Other work on Cooperative Research Centres (partnerships between academia, industry and government) suggests many participants struggle with juggling their divergent loyalties and commitments, including the tension between their personal versus group needs (Garrett-Jones et al. 2013; see also Lefroy et al. 2012; Webber 2013). For those working on collaborative research projects these challenges are likely to be especially acute.

Lack of time was the number one barrier to interdisciplinary research cited across respondents, trumping and intensifying all other concerns. A raft of other research endorses this sense that many academics are feeling intensely time pressured. Related in part to the discordant expectations upon academics, this pressure is not unidirectional but occurs at many scales and in many guises as academics work to numerous time frames simultaneously, often adopting different roles and identities in each (Briggs 2007; Knights and Clarke 2013; Smith 2012). The general complexity of the dynamism of academic life was arguably amplified during ISG projects where much time had to be found for thought and conversation as the same time as the end of the project loomed quickly, and multiple ideas, agendas, disciplines and processes had to be juggled and then swiftly coordinated into coherent products.

Table 3: Project speed humps: challenges in doing interdisciplinary research projects reported by respondents

Research idea & team formation	Project design & set-up	Active research	Writing up & publication	Next steps
- Identifying a suitable and appealing interdisciplinary research topic - Establishing initial list of disciplinary input needed - Finding and securing suitable collaborators - Agreeing approximate contributions - Finding time to discuss and jointly generate grant application	- Getting to know and understand collaborators - Establishing expectations around collaboration - Understanding each other's disciplinary perspective and role - Identifying a mutually suitable and feasible research aim and question - Identifying and agreeing on suitable research methods	- Distributing tasks and resources appropriately and efficiently - Finding and employing suitable staff - Maintaining own and others' commitment to the project - Managing individuals' different work situations, styles and ethos - Resolving emergent epistemological and conceptual tensions - Addressing emergent needs in research team or design - Ensuring appropriate budget flows - Intellectually leading project in effective and respected manner - Managing personalities and interpersonal conflicts	- Agreeing on key findings and framings - Sharing the writing - Different languages, literatures, writing styles & conventions - Choosing/finding mutually suitable publication outlet(s) - Explaining/defending the interdisciplinary nature of work to peer reviewers - Navigating the field of research codes - Engaging diverse internal and external audiences on the research - Receiving recognition in one's PDF	- Completing outstanding data collection, writing tasks or other work - Sustaining collaborative relationships over the long term - Identifying grant opportunities and managing application requirements - Integrating implications of new understanding into own work

4.3 Intellectual and identity work in interdisciplinarity

4.3.1 Being (inter)disciplinary

How researchers engage with interdisciplinarity and to what effect is shaped by their disciplinary identity and organisational location. In this study, interviewees (mainly from HASS disciplines because of the sampling) expressed various levels of affiliation to one or more disciplines, with many identifying with multiple disciplines, some even across the STEM-HASS divide and some to the extent that any disciplinary identity they had was fading (Table 4). Some of those with multiple disciplinary allegiances talked about *"wearing different hats"* or indicated that they played a *"knowledge broker"* role between groups of peers[14]. Others expressed similar sentiments about operating between different sub-fields. For example one interviewee talked about having a *"dual identity of empiricism and the interpretive"* within his one STEM discipline. All but three of the interviewees identified with at least one discipline in which engaging with interdisciplinarity is quite common, or even the norm. As one said: *'I can't imagine working in any other way'*

A notable characteristic of nearly all of the interviewees was how reflexive many were about their (inter)disciplinary identity. It was obviously something they had reflected on before. In one sense this stems from working in interdisciplinary settings given the way such contexts can require individuals to give themselves a disciplinary label and behave as a "representative" of their discipline (Carter and Housel 2013). It also stems from the constant need to fit the outputs of such interdisciplinary into discipline-based FOR codes. As one interviewee explained:

> *I've always had dual disciplinary interests... It means very little to me really, I mean I understand why people care about it. People are bothered about it at Melbourne much more than anywhere else I've ever worked in a way that I think is profoundly unhelpful a lot of the time... People can get very impatient with academics like me because my body of work doesn't sit neatly in what is considered to be [X discipline] or what is considered to be something else... I have had conversations on many occasions with people who would like me to, you know "Can you please publish in X?"... Well yes, I do that, but I don't only do that.*

Thus although many individuals do not work within tight disciplinary bounds, they are not able to forget such bounds because of constant organisational reminders of ways in which they don't fit.

Many interviewees indicated a sense of being organisationally "in between" - of sitting in what some call "shadow spaces"[15]. It seems that, at least among HASS researchers, those who participate in interdisciplinary research tend to be those who position themselves - or who are (subsequently) positioned - as somewhat

[14] Knowledge brokers is a knowledge management term used to describe people or organisations that facilitate flows of knowledge across boundaries (e.g. between scientists and the public; academics and policy makers; different government agencies). See for example: Meyer, Morgan. 2010. "The rise of the knowledge broker." Science Communication 32(1):118-127

[15] See for example Pelling, M., C. High, J. Dearing & D. Smith. 2008. "Shadow spaces for social learning: a relational understanding of adaptive capacity to climate change within organisations." Environment and Planning A 40(4):867-884.

separate to the intense core workings of the university. Many interviewees work within organisational units that are in some way "unusual" relative to the "mainstream" structure of the University - that is, either outside the traditional discipline-based structure or in somewhat unusual corners of it. For example, while some were in a traditional faculty such as Medicine, they were often then within a somewhat unique segment of it (e.g. an interdisciplinary centre or in a small unit formed around a newer and generally quite divergent disciplinary identity). One interviewee described how their units were positioned in Science:

> *...always been perceived as kind of a boutique thing, particularly at The University of Melbourne... Some people have been brilliant - like anyone who's higher up the chain gets it - but once you get to the faculty level it's "I don't quite understand where you fit"...'*

This quote illustrates that in numerous cases, the unusualness of the organisational unit reflects its difference in "culture" from its surrounding (STEM) faculty. While being unusual in this way is not at all a measure of success - especially given that some of the now "unusual" parts of the University may be best placed to serve the University's impact agenda or secure external funding - it does point to potential challenges fitting comfortably and securely into the broader institution. As found by others (e.g. van Rijnsoever and Hessels 2010), basic disciplines tend to focus on disciplinary collaboration and 'strategic' disciplines tend to engage in interdisciplinarity to a greater extent. This self-perpetuating alignment could help generate an institutional and sectoral landscape in which disciplinary islands exist within a flowing ocean of interdisciplinary engagements, with those swimming in the latter more likely to meet fellow aquatic creatures than disciplinary land-dwellers.

With marginality can come a greater awareness of difference, power and one's position in the whole[16]. For, it is mainly those outside of the dominant structure that see and think about that structure, whether the structure in question is the disciplinary or organisational landscape. As the analysis above suggests, the interdisciplinary identity and research activities of many interviewees is facilitated by their organisational position in units inherently accustomed to disciplinary difference and crossover. It is interesting to then reflect on the inverse situation: that of the three interviewees positioned securely within "mainstream" and strongly disciplinary parts of the university (core disciplinary departments) where interdisciplinary research is not common. Both of those in humanities described how difficult it is to engage substantively with interdisciplinarity in this context, which is likely both because interdisciplinarity is uncommon in their basic disciplines (van Rijnsoever and Hessels 2010) but because even formal research collaboration a rarity in the humanities (as research by Lewis (2013) attests). One stated that his disciplinary peers considered his interdisciplinary work "worse than useless" because of its failure to fit existing publishing ideals:

[16]There is an extensive literature in feminist, post-colonial and race studies, for example, about how people and research fields positioned 'on the margins' experience difference. This includes Gayatri Chakravorty Spivak's seminal idea of the 'subaltern'. See for example Chaturvedi, V 2012 Mapping Subaltern Studies and the Postcolonial Verso Books, London. See also Pettman, J J & Jan, P 1992 Living in the margins: Racism, sexism and feminism in Australia Allen & Unwin Sydney, Sibley, D 1995 Geographies of exclusion: Society and difference in the West Psychology Press.

> *I couldn't publish [the ISG project findings] in my field because it was very applied... People in my discipline don't care about these publications, they're worthless... If it is genuinely interdisciplinary - in my discipline anyway, which is a very snobby one - it's worthless. In fact, it's worse than worthless because it takes you away from doing proper stuff... Top journals in my field wouldn't touch the sort of stuff I did [in the ISG project] with a bargepole.*

The other commented that in his field collaborative research was uncommon not only because of the discipline's scholarship conventions but its (or his faculty's) strong focus on the excellence agenda:

> *A lot of people in [the discipline] are completely individualistic in their research agendas. We historically have very narrow sort of research agendas that's generally just ourselves and maybe one or two others in [the discipline]... And now we are drawn back into the faculty to meet our own internal sort of targets and what have you... to meet these internal expectations around output and productivity... I keep getting drawn back more and more into the faculty...*

Given such antagonism, the question of what motivates and enables such individuals to engage in interdisciplinary research - to work against the grain - takes on extra significance. The case of these individuals suggests that it is helpful to possess high levels of institutional capital from other sources (notably seniority and gender[17]), supporting the argument that the career risk posed by interdisciplinarity varies with individuals' position within the academy (Rhoten and Parker 2004). As one of the two interviewees commented, now that he had a Professorship, he feels much freer in his research choices. The case of the other interviewee within a "mainstream" part of the University (a large STEM discipline) further supports this contention. He described for example how over years he had worked with senior international colleagues to shift his discipline toward accepting qualitative research of the sort he does. While not downplaying this achievement, most academics' options for adapting to disciplinary constraints do not include such environmental transformation.

More than being "tolerated" in disciplinary strongholds, interdisciplinarity may even confer some advantage to individuals. Now that academics are increasingly impelled to show entrepreneurial flair (Bozeman et al. 2013; Fogelberg and Lundqvist 2013; Smith 2012), and the University is branding itself on increasingly thematic rather than disciplinary lines, engagement with interdisciplinarity may give individuals a useful relevance and "point of difference", contributing to their and their faculty's profile. As interdisciplinary opportunities proliferate, and people in and out of the University look for collaborators, these individuals' unusual willingness to collaborate may also offer them an advantage over disciplinary peers in any emerging extra-disciplinary "market" for their disciplinary expertise, allowing them to be more selective and presumably successful in their interdisciplinary endeavours. Like some other respondents, all of the interviewees in un-interdisciplinary-friendly fields indicated

[17] Academia as a whole is still biased against women. See for example Diezmann, C & Grieshaber, S 2013 Australian Women in the Academy. in Patton, W ed Conceptualising Women's Working Lives. SensePublishers, Harris, C, Ravenswood, K & Myers, B 2013 Glass slippers, Holy Grails and Ivory Towers: gender and advancement in academia. Labour & Industry: a journal of the social and economic relations of work 23 231-44. Sheltzer, J M & Smith, J C 2014 Elite male faculty in the life sciences employ fewer women. Proceedings of the National Academy of Sciences 111 10107-12.

such a dynamic may be in play when they noted that they are being inundated with requests from potential external collaborators to represent their discipline in new interdisciplinary endeavours.

These cases suggest that interdisciplinary researchers are somewhat like 'institutional entrepreneurs': individuals who are able to act as effective 'change agents' because they belong to existing groups enough to be recognised and respected, but not enough to lose their vision of other possibilities or connection with groups beyond (Kisfalvi and Maguire 2011). Combined with the finding above about many respondents seeming to have a highly strategic outlook on their research and careers, it paints a picture of interdisciplinary researchers as academics with dual attachments to their organisational/disciplinary home but also the wider world. They seem to have an especially broad view and interest in what is going on around them, across the University as well as in their discipline.

The disciplinary and organisational location of individuals engaged in interdisciplinarity is important because such relations affect these individuals' perceptions and experiences of interdisciplinarity. Through being positioned as individuals or within organisational units that are slightly at disciplinary odds with their surrounds, interdisciplinary scholars seem to have a kind of "cross disciplinary existence". Mediated by their institutional capital, individuals' location in their surrounding structures also shapes the extent to which they can feed back into the broader organisational, academic and social landscape, affecting the degree to which they generate interest in interdisciplinarity around them.

Table 4: Overview of the disciplinary and organisational location of the interviewees in terms of interdisciplinarity

Interviewee	Professional level	Gender	Broad "culture" of each discipline the interviewee identified with	Is it common for those in these disciplines to engage in IDR?	Does the individual's organisational unit have a strong disciplinary identity?	Is the organisational unit a "core" or "unusual" part of the larger University structure?
1	A/Prof	F	Social science Social science	Yes Yes	Yes	Unusual
2	A/Prof	M	Science Science Humanities	Yes Yes No	Yes	Unusual
3	Prof	M	Humanities	No	Y	Core
4	Prof	F	Social Science	Yes	N	Unusual
5	Res. Fellow	F	Social Science Science	Yes Yes	Y	Unusual
6	Snr Lecturer	M	Science	Yes	N	Unusual
7	A/Prof	M	Humanities	No	Y	Core
8	Prof	F	Social Science Social Science	Yes No	N	Unusual
9	Prof	F	Social Science Science	Yes Yes	N	Unusual
10	Prof	F	Social Science	Yes	Y	Unusual
11	Prof	M	Science	No	Y	Core
12	A/Prof	F	Humanities Science	Yes Yes	N	Unusual
13	Prof	F	Social Science	Yes	Y	Unusual
14	Prof	F	Social Science Social Science	Yes No	N	Unusual
15	Prof	M	Social Science	Yes	Y	Unusual

4.3.2 Epistemology and ethos

Survey respondents were asked what they understand by the term interdisciplinarity. How individuals conceptualise interdisciplinarity reflects the general epistemology[18] they are working from. This is important for two reasons. First, some interviewees argued that epistemological differences are a meaningful divide at The University of Melbourne and affect academics' identity and experiences. Referring to a long-standing tension between quantitative (numbers-based) and qualitative (words-based) research traditionss[19], (DeLyser and Sui 2012; DeLyser and Sui 2014; Sui and DeLyser 2012) one commented:

> *It's not so much the qual/quant thing, it's the what's behind that, which is the positivist versus interpretivist thing.... You know, if you scratch the surface that's probably a big tension... That's pretty significant in Melbourne. People are terribly wedded to that here. They sort of wear it like a badge really...*

Second, we need to deal with epistemology because not only do all members of an interdisciplinary research team work from within a particular epistemology, but interdisciplinarity itself is understood in epistemology-specific ways. The dominant understanding of interdisciplinarity - as the "integration of knowledge" (mentioned above) - is not a neutral framework in which epistemological and epistemic differences are then sorted out. Its underlying jigsaw metaphor reflects the idea that we share a single reality, that we each do research on a different bit of it, and that a more *comprehensive* (as in larger) understanding of that reality can be achieved by fitting the component knowledges together (tested and stripped of our particular biases) (Ison 2010). Its assumption about the basic commensurability of different knowledges indicates that it stems from a broadly positivist epistemology. This means that in projects centred on a jigsaw approach (acknowledged or not) those who work within non-positivist epistemologies, and thus have knowledge that is not easily recognised by or integrated into the group's model of shared knowledge, can be disadvantaged from the outset[20].

Knowledges associated with the other major epistemology active in academia[21] - social constructivism or interpretivism[22] - are among those not easily aggregated. An interpretivist framing sees interdisciplinary research differently: as the bringing together of different perspectives to create new ones (either better or just

[18] Epistemology refers to what one believes to be true and why. It is related to but distinct from what one actually thinks exists.

[19] This divide exists even within the integrated 'intra-discipline' of geography, as recent reports on efforts to transcend it indicate: DeLyser, D & Sui, D 2014 Crossing the qualitative-quantitative chasm III: Enduring methods, open geography, participatory research, and the fourth paradigm. Progress in Human Geography 38 294-307, DeLyser, D & Sui, D 2012 Crossing the qualitative-quantitative divide II: Inventive approaches to big data, mobile methods, and rhythmanalysis. Progress in Human Geography, Sui, D & DeLyser, D ibid. Crossing the qualitative-quantitative chasm I. 36 111-24.

[20] "Positivism" is used here to loosely refer to the idea that there is an objective reality that can be known through careful study (either theoretical, as in Rationalism, or experiential, as in Empiricism). As used here, it incorporates the ideas of 'post-positivism' – that most scientists these days would accept - which acknowledge that researchers' views of the world are not neutral and that the particularity of their perspectives (conceived as biases) can occlude their ability to perceive the truth.

[21] It is recognised that this binary framing is a gross simplification but there is not space to go into more detail here.

[22] "Interpretivism" is used here to loosely refer to the idea that we cannot escape the limitations of our own perspectives and access an independent truth and so all knowledge is context-specific. As used here, it incorporates the ideas of 'social constructionism' that emphasise that we individually and collectively see and act in the world on the basis of our continually reconstructed social models. This does not necessarily mean rejecting the idea that there is a single reality (as a social constructionist ontology does) but accepting that we can never "really" know it. Knowledge is therefore continually open to contestation from others.

different) (Mauthner and Doucet 2008). Knowledges are conceived not as pieces of a jigsaw puzzle but as messily overlapping "lenses" constructed strongly by language.

As Aram (2004) discusses, the existence of these two broad epistemologies leads not just to diverse content within interdisciplinary research, but two distinct understandings of interdisciplinarity *per se*:

- A "New Knowledge model": interdisciplinarity as the fine-grained integration of different but ultimately commensurate information in order to create new knowledge. Associated with a positivist epistemology, this is the dominant approach in the literature.
- A "New Perspectives model": interdisciplinarity as the meeting of alternative and often incommensurate knowledges in order to forge new understandings about a topic, associated with an interpretivist epistemology.

Survey responses confirmed that these two broad models are indeed imagined by different researchers (Table 5), although many put forward various intermediate perspectives.

A further crucial contextual difference that emerged in the interviews reflects the tension between the excellence and impact agendas. This can be considered as the extent to which academics are focused on research questions that are "internally oriented" towards their academic peers or "externally oriented" towards broader society (noting that in a growing number of fields the former is encompassing the latter[23]). The existence of this tension was explained by one interviewee:

> *People publish in journals that, you know, are this wide [holds up two fingers] in terms of disciplinary breadth... But for somebody like me who's interested in applied research, policy impact, making a difference, it counts for very little, you know.. I have no interest in that. I understand that people do, I understand that that's how great academic careers are forged, but...*

As discussed in the Introduction, the rise of interdisciplinarity is often associated with the "impact" agenda: the idea that research should be directly relevant and legitimate to society, (or at least to those funding research). But this does not at all mean that all academics who engage in interdisciplinarity do so for this reason. Interdisciplinarity is also a long-standing and growing feature of academics' intrinsic pursuit of new ideas.

We can combine the distinction between what interdisciplinary research produces with the academia/society distinction implicit in the impact agenda to generate a two dimensional classification of different orientations towards interdisciplinarity (Figure 7). A heuristic tool, the figure presents four quadrants that each represent

[23]See for example a high profile call for science to focus explicitly on real world environmental issues: Lubchenco, J 1998 Entering the Century of the Environment: A New Social Contract for Science. Science 279 491-97. And discussions about the need for 'public sociology' Burawoy, M 2005 For Public Sociology. American Sociological Review 70 4-28. and 'public geography' Smith, J 2013 Geography in public and public geography: past, present and future. The Geographical Journal 179 188-92.

Table 5: Descriptions of interdisciplinarity from two broad epistemological positions: the new knowledge model (associated with positivism); and the new perspectives model (associated with interpretivism)

"New knowledge model" of interdisciplinarity – example responses	**"New perspectives model" of interdisciplinarity – example responses**
Integrating expertise from different disciplines to address a problem	More than one school of thought/paradigm being applied to a research problem
Collaboration between researchers of different backgrounds with complementary expertise	Finding common areas of interest and bringing different paradigms to assist in unpacking the research topic
Using disciplines' strengths in a complementary manner to solve problems in a way none of the individuals could do on their own	Combining people with diverse approaches to tackle an important problem
Identifying and exploring the potentialities when problems on the periphery of technical disciplines are addressed	Working with colleagues who have a totally different world view
Working together with colleagues from different specialities to push fields forward and accelerate scientific discovery	Offering vastly different and new viewpoints into what was traditionally one avenue of learning
	Offering multiples solutions, not a single solution

a different "take" on what interdisciplinarity is about or good for. The resultant stances - which we can euphemistically call Pioneers, Experts, Critics and Catalysts - are ideal types that actual researchers may adopt to varying degrees at different points in time or in different projects. Interview responses (illustrated in the figure) indicate that researchers at Melbourne encompass this variety.

As mentioned earlier, the New Knowledge model of interdisciplinarity was dominant among survey respondents. Also expressed was a mostly academic motivation for engaging in interdisciplinarity, in contrast to the association of interdisciplinarity with the impact agenda and indicative of the strength of the excellence agenda at Melbourne. This combination of preferences means that, as could be expected, most respondents seem to hold to the "Pioneer" ideal, pursuing interdisciplinary research to add new knowledge to their field. This was reinforced by survey respondents' frequent use of spatial metaphors about crossing frontiers and boundaries (e.g. *'crossing into new areas', 'working at the periphery', 'working outside my comfort zone'*). An interviewee similarly commented that his notion of a successful interdisciplinary project was 'breaking into new territory'.

The idea of breaking into or seizing new territory resonates with the intellectual task facing an interdisciplinary group, who between them have to find a way of working in order to then locate some intellectual "common ground". We turn now to this challenge of actually "doing interdisciplinarity".

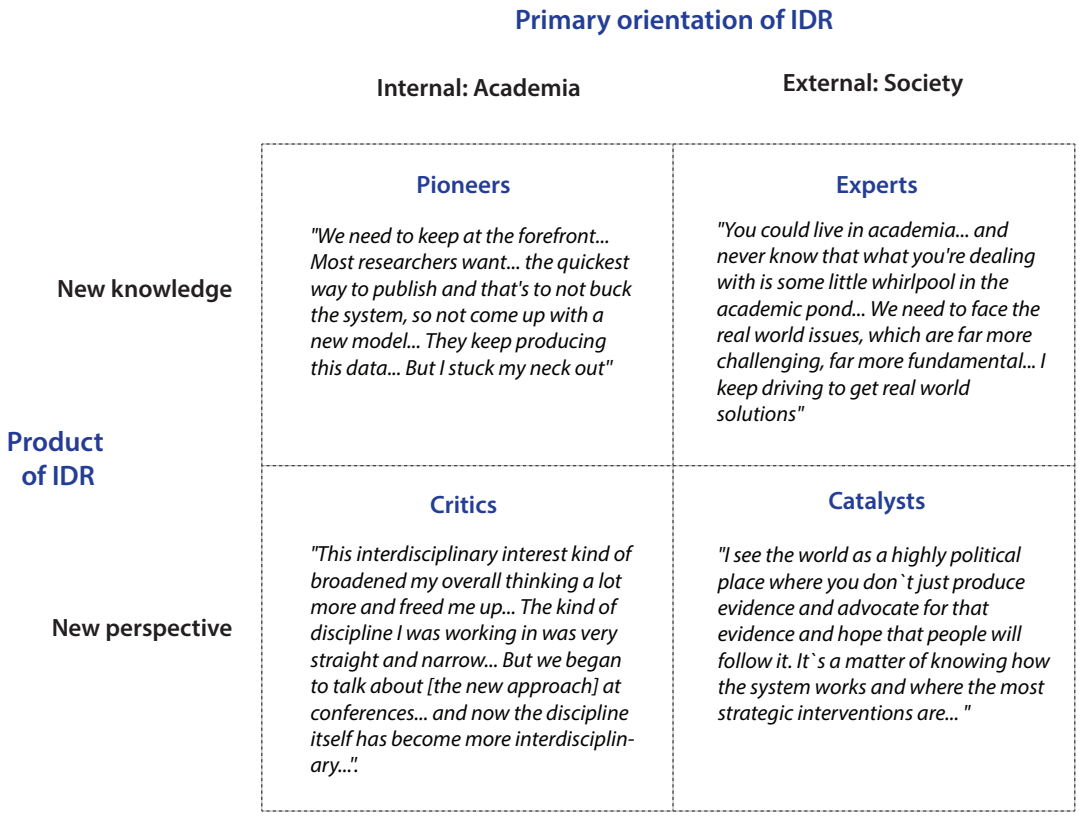


Figure 7: Typology of different "roles" researchers may adopt in doing interdisciplinary research (inspired by Aram (2004) and populated with quotes from the interviews).

4.3.3 Cultivating common ground

How did the project groups go about actually creating interdisciplinary knowledge and producing actual outputs to communicate that knowledge to others? Core to all groups was the generic issue of communication. But again this basic framework is fractured along epistemological and thus disciplinary lines, with different

epistemologies generally conceiving of the role of communication in collaborative research differently, as may be expected given the importance of language to the interpretivist approach. Holbrook (2013) discusses how these translate into three broad understandings of the role of communication in collaborative interdisciplinary research: striving for clarity; learning a new language; and creating a new language[24]. With the latter two associated with mild and strong interpretivism, each reflects a fundamental difference in how knowledge is conceived and thus interdisciplinarity approached. Recognition of this difference affects not just knowledge production in a collaborative project but the whole approach to group work. When such differences are not recognised or respected, projects can be conflicted from the very start.

In keeping with the suggestion above that most survey respondents seem to come from a broadly positivist approach, many used the language of combining expertise and specialisations to describe the act of interdisciplinarity. The focus in this "plan-to-integrate" approach, as it could be called, was on carefully mapping out overlaps in information or knowledge (e.g. by allocating different disciplines to different scales) and working to fuse it together. In many cases, the process of integration was described in terms of establishing a division of labour determined along expertise lines. For example, some respondents wrote:

> *The combination of disciplines was achieved by combining the expertise of Prof X in membrane trafficking with Prof Y in monoclonal antibody therapies, protein engineering and translation.*
>
> *The success of our collaboration is attributed to our understanding of the power and limitations of our expertise. Each of us play a key role in making this project to work. Specifically, X and his team performed the platelet function test... Y and his colleagues performed the synthesis of the chemosensor... Z designed and synthesised the probe...*[25]

In contrast to this emphasis on a division of labour, others underlined how tasks (and thus knowledge) were at least partially shared:

> *We shared the data analysis. Also when key experiments are performed participants from different groups assist.*
>
> *We co-authored a paper and some conference presentations so that we could work through our conceptual approaches. We co-supervised some graduate and undergraduate research projects and have worked closely on the technical issues on the algorithm development.*
>
> *We had meetings to plan projects, then to discuss results. New methods were learned by one member of the team that necessitated training from other members of the team.*

[24] The labels Holbrook actually uses are the Habermas-Klein approach versus the Kuhn-MacIntyre and Bataille-Lyotard approaches. In the name of clarity, I have translated these into plain English.

[25] Added detail about the methods is deleted in the name of confidentiality and space

The emphasis on sharing experience moves closer to the stronger role given to communication in the "learning or creating a new language" vision of interdisciplinary knowledge work that is generally adopted by those working within a (mild) interpretivist epistemology. Communication is acknowledged here as a major challenge and something that people have to work at if clarity and understanding 'shared framing' is to be achieved (e.g. Lélé and Norgaard 2005; Oughton and Bracken 2009). As one respondent wrote, his group worked towards interdisciplinarity through:

> *Discussion, meeting different groups, being excited and inspired by each other's expertise and a cohesive team of researchers.*

Communication in this framework remains a mode of transporting rather than constructing meaning, a scythe to cut through ambiguity and misunderstanding and reveal the shared truth below. This "talk-to-consensus" model, as it could be called, frequently utilises 'boundary objects' (cf. Star and Griesemer 1989): a tangible or intangible focal point (e.g. a specific object, model, or output) on which a group tries to develop enough agreement to at least approximate a consensus view. Examples of boundary objects mentioned in some of the quotes above include co-authored publications, a co-developed algorithm, and a new method.

Boundary objects may also take the form of a concept or term common to different disciplines but understood differently (e.g. "vulnerability", or the idea of "scaffolding" discussed in the first MICE report). Working at a conceptual level requires more far-reaching exploration of each other's understandings and can (unexpectedly) open up wide horizons of difference. One interviewee described for example how progress in an interdisciplinary project can be hampered if it is found that a common term such as "model" means different things to different team members; revealing what Rambur (2009) calls 'deceptive similarities'. This interviewee explained that his ISG project explicitly examined a shared concept across the science-social science divide represented by the team members, noting that much 'robust discussion' and a 'thick skin' was needed. As he commented:

> *It is a long conversation to get what [his collaborator] does and what I do together on the same page... The connections aren't obvious.*

This brings us to a stronger role for communication in performing interdisciplinarity: the idea that participants need to do more than learn a few "phrase book" terms about another discipline. To try to integrate knowledge, this approach suggests, each needs to learn how to speak the others' disciplinary language (Holbrook 2013). Becoming literate in another's "language" refers here to learning to see the world through their eyes, while retaining one's own perspective in order to then assess the intersections. But in going through this process, it is often found that the languages are not aligned. Thus translation between and integration of them is not possible without distorting the meaning of one or both original frameworks. Indeed, strong interpretivists argue that such incommensurability of perspectives is always the case. In this view:

> *...a discipline is a sort of conceptual scheme whose adherents share some basic orientations towards the world. Because these basic orientations can differ in important ways, communication between disciplines (interdisciplinarity) can only happen when one learns another discipline from within, as a sort of second first language. This allows for the possibility of dialogue between disciplines, as long as the discussion is held on disciplinary terms. Something similar can happen with other, non-academic conceptual scheme (transdisciplinarity). What cannot happen... however, is integration, which will always result in what the adherents of a particular conceptual scheme would characterize as a misunderstanding (Holbrook 2013, p.1877).*

Numerous interviewees discussed encountering this sort of issue:

> *You know, we've all been in the situation where we've been the token sort of qual person or the token quant person. I think it is a challenge...*
>
> *There was an inherent tension between the kind of quantitative research that [my collaborators do], and my kind of research which is interviewing people and, you know, being involved in things...*
>
> *If the tools of the trade are very different, then it's very hard to kind of get the interdisciplinarity to work... And so in anthropology, they do a... what do they call it again? It's not a case series, it's a case... Oh, it will come to me... But in X [science] we do objective research... So I think the crux of successful interdisciplinary research is if there's enough overlap between the methods or techniques used...*
>
> *We're having a presentation and my eyes were out on sticks at one point [because of what a colleague from another discipline was saying]... I suppose it's quite legitimate in [their] field but... 'cause I'm a [different discipline] I'm thinking "Wow! How do I get some traction with that??" Because all along the way I'm thinking "But there are so many assumptions here!". So we go underneath and say "Look, why do you assume this? Is there any proof?"..." No, no, they say, we don't need to proof, don't need to worry about that". And so off it goes.... So we're really like –"Whoa!". Looking at quite different ways of relating to the world, you know... Completely different epistemologies.*
>
> *I think people don't realise how long it takes, like the investment. ... You see this all the time in ARC grants...a lot kind of faked up collaboration... people who've never worked before together and don't actually seem to understand how hard this can be, particularly across disciplinary boundaries... People just think "We'll just... get the money and that'll solve the problem"... There's a lack of understanding that it's hard work. And I think there's a lack of ... what I was saying before, about respect. So people think, you know, "I'll be able to tell them, persuade them that I'm right" - without sort of saying, you know, that's actually a different perspective and it's adding something different to the conversation and it's worth listening to. I think some people aren't prepared for that.*

Given these challenges, how do people approach interdisciplinary collaboration in such situations? Holbrook (2013) argues that the theoretical solution is to abandon the attempt to integrate existing knowledges and work together to create a new one[26]. This "talk-to-create" mode of interdisciplinarity, as it could be called, was not reported by any respondents in this study, indicative perhaps of how difficult and time consuming it is. But various other responses were evident. Perhaps the primary one was simply to resolve to work only with like-minded people in the future. Numerous interviewees suggested they had made such a choice. As one said:

> *I mean there's no point in pretending... If your views - your epistemological bases - are so profoundly different then it's going to be incredibly difficult to reach a resolution about why you should answer this question in this particular way.*

For those still in the midst of a difficult cross-epistemological project, some recounted trying to bring the problem of epistemological tensions to the attention of the group. This involved crossing the initial hurdle that some members of the group did not see the issue. As the interviewee who recounted the story about the presentation remarked: '*From the point of view of [her colleague], he didn't even necessarily think about epistemology! This is just what they do, he said*'.

Third, another suggested that what was needed was to acknowledge the incommensurability of views and try to move the group forward regardless, towards some kind of consciously- compromised outcome. Reiterating the calls for strong intellectual leadership seen above, she explained:

> *The key I think is strong leadership. I think it can get like Groundhog Day if somebody doesn't step in and say "This is terrific but what we've got is this; we haven't got that and that. So can we cohere around this? No? OK... Some of you may not, some of you will. Right, thank you. Let's go forward"... You can't have everything washing around forever. It's just not going to cohere, you know... There is in some respects a certain amount of violence that gets done. I'm not saying you're horrible to people, I'm saying that you can't constantly respect everything in the same way. You do have to do a violence and say "OK, this is the frame we're using. I know this needs it, but those things can't be looked at". That's a form of violence, isn't it, because... it's a crushing thing... It has to become focused at some point, it cannot be a mirror replica of the complexity of the whole world... But it never happened that way [in her project]. I suppose we were trying to find some kind of non-existent consensus...*

The point here is critical awareness of what is needed to bring a project to a point of closure. Such awareness can be precipitated by the writing up process, where some degree of finality, coherence and glossing is required. As found by the first MICE report, it is at this stage that a lot of the sort of issues discussed above can come to a head; too late in many cases to affect the direction of the research but early enough to make the development of shared publications problematic. From identification and interpretation of key findings, settling

[26] On the value of creating a new language or 'praxis' to think differently with, see Ison, R 2010 Systems Practice: How to act in a climate change world Springer, and The Open University, London.

on conclusions (and in some cases recommendations), adopting an agreed tone and style of writing, engaging with certain literatures, and - of course - selecting which journal (and so FOR code) the group will target, were all mentioned by interviewees as ongoing difficulties. The question of journals was especially highlighted as a thorny issue in light of the intensifying focus on journal as well as university rankings in academia.

Overall, what is apparent in these experiences is the inseparability of group work and knowledge work in interdisciplinary collaborations. More specifically, we see how those from an interpretivist perspective may be drawn to not only contribute their expected knowledge on a project, but to play additional roles within the group. This extends beyond the common complaint - reiterated by some interviewees - that those from HASS disciplines are expected to (only) do the "fluffy" knowledge work in research projects, such as managing stakeholders and translating and communicating (already determined) research findings. It suggests that by virtue of their sensitivity to the existence of epistemological issues - notably the 'disciplinary chauvinism' (as one interviewee put it) that excludes their own epistemological perspective - interpretivist researchers can be forced into a greater intellectual leadership role than they or others anticipated (or welcome). That is, as intensive dialogue is found to be needed for the group to achieve its intended (or any) degree of interdisciplinarity, those sensitive to the knowledge politics involved can be foistered into a more active role in managing the group process, which can go smoothly or can be awkward if it unsettles the formal leadership roles in place (Figure 8). In the process, such researchers help to simply illuminate the need for such group-oriented and knowledge-oriented research work which, as discussed above in terms of project management roles, are often not consciously addressed.

Figure 8: The roles frequently performed by HASS researchers in IDR projects

4.4 Suggestions for interdisciplinarity

Interdisciplinary research presents considerable rewards and risks, opportunities and challenges. Aligned with a diversity of agendas and perspectives, it also faces an array of constraints. Respondents indicated that at Melbourne generating more and better interdisciplinary research requires addressing a range of key intellectual, inter-personal and resourcing issues (among others), manifest at the levels of projects, individuals, organisations and the Academy (Table 6).

Table 6: Why does more, and more effective, IDR not occur? Respondent answers grouped according to type of difficulty and multiple levels at which they are operating.

		Type of difficulty		
		Intellectual	**Inter-personal**	**Resourcing**
Level of operation	**Project**	Knowledge difficulties involved in IDR (technical, philosophical)	Challenging group dynamics	Inadequate time and money to do IDR properly
	Interviews	Research interests do not seem to require or fit with IDR	Inexperienced and uninterested in collaborative work	Perceived lack of organisational support for IDR
		Not able to or interested in thinking across disciplinary boundaries	Do not know or like specific potential collaborators	Lack of willingness or capacity to take on perceived professional risks of IDR
	Organisation	Discipline based organisational structure mitigates against IDR	Organisational culture does not encourage IDR	Inadequate direct funding available for significant IDR
		Particular framing of organisational and research priorities interpreted by some as discouraging IDR	Not enough people with the right sort of expertise employed at the University	Resourcing pressures throughout organisation limit time and encourage managers to look for "quick wins"
	Academy	ARC and NHMRC processes focused around disciplinary differences	Most academic networks are largely discipline based	Cuts in government funding of university research
		Grant assessors and journal editors unfamiliar and uninterested in much interdisciplinary work	Researchers strongly focused on their disciplinary peers' opinion of their work	Deregulation of student fees encourages development of new or larger courses, reducing some academics' capacity to undertake (challenging) research

Given the above challenges, the question is how to best support and foster interdisciplinary research of the desired quantity and quality. Perhaps the most encompassing challenge listed above is 'a perceived lack of organisational support for interdisciplinarity'. Such support is about more than the quantum or frequency of funding rounds. As one interviewee reflected, it's a broader question of perceived 'institutional commitment':

> *There's no question... that being in an institutional environment where at some level this kind of work is valued, and there is resources - that makes a difference. It's not everything but ... it's pretty important. So, there's something about money and there's something ... There's certainly something about an institutional culture that gives you permission to do this. Though I can't quite make up my mind about Melbourne on that, you know! ... Most days I think yeah the University gets it. But the University's not then terribly well-structured to deal with that 'cause that's where the fiefdom thing comes in .... So that's challenging. And there's something about institutional commitment that's important.*

Comments from other respondents suggest that institutional commitment involves tackling the structural impediments to interdisciplinarity in both the University and the broader academic environment (Table 7). It is also about moving beyond a deficit model to consider how interdisciplinary research could flourish and excel. Creating a culture in which interdisciplinarity is not only tolerated but celebrated could help to surface more of the interdisciplinary research that is already occurring '*under the radar*' - as one interviewee suggested was common in her non- interdisciplinary-friendly faculty. It could also help create a space for different sorts of research questions to be asked. Another interviewee explained:

> *So much of this is about the individuals who are disposed towards asking questions that require you to have a multiplicity of perspectives in order to answer them effectively. A passion for engaging with people who don't see the world the way they do and a curiosity for just finding out what happens when you put all of those people with different perspectives in a room together. So there is something about an individual's preparedness to take on board the fact that, you know, somebody else is going to say "Well I don't understand why from your perspective this is more important than that. Or why this is the model that you use" - or whatever it happens to be. ... It's sort of a combination of skills plus disposition I think that makes this happen, and you can't do that without institutional support. But all the institutional support in the world won't create that if you don't have those individuals who are prepared to do it.*

Research on innovation suggests that opportunities for informal collaboration are equally as important as those such as defined research projects for the generation of creativity. This includes the generation and nurturing of sound and exciting interdisciplinary research topics of the sort discussed above as essential to project success; topics which incorporate an appropriate collection of perspectives and can sustain someone along their research track. These do not emerge out of the ether but out of sustained conversation, akin to the social learning within 'shadow spaces' that Pelling et al. (2008) describe as an essential prerequisite to

identifying and seizing opportunities for change (as a funding call could be conceived as). Numerous researchers called for support to foster such interactions, emphasising both the need to meet people and the need to have the time to engage meaningfully.

New interactions begin with the basic question of awareness of others' existence. This is an issue not only in terms of some researchers (such as early career academics) having low visibility to others (as discussed above), but in terms of the University appearing as a low lit, mottled landscape to those trying to discern potential collaborators. For those lacking a clear panoptic view of relevant institutional members, identifying potential collaborators requires a committed search, especially given the genuine conversation needed with each new find. One interviewee called for the University to short cut this process by facilitating more interactions:

> *One of the barriers, I guess, is the time involved in knowing who to collaborate with. And so if we actually had someone that could facilitate that a bit better that'd be really good.*

Others proposed forums to talk about important big topics such as those encompassed in the Grand Challenges, pointing out that the absence of discussion about these themes was a lost opportunity not only in terms of drawing out like-minded researchers but to progress thinking about and innovation on the topics within the institution.

Besides creating arenas for cross-disciplinary conversation such as networks and communities of practice, suggestions in Table 7 point to the potential for more top-down direction. Of particular note is the idea, proposed by numerous respondents, of professional development opportunities around interdisciplinarity. Such a notion encounters many of the epistemological tensions evident at many levels of projects discussed above. Can insights about interdisciplinary collaboration be generated, as the 'methodical integrationists' (Holbrook 2013) and proponents of "the science of interdisciplinarity" suggest, or must all researchers do an apprenticeship in the craft of interdisciplinary collaboration, given the inherent uniqueness of each case (Frodeman and Mitcham 2007)? Recently developed workshops at other universities on doing interdisciplinarity suggest interdisciplinarity is an understanding and skill that can be taught to some degree. König et al. (2013) conclude that their proposed interdisciplinary research management framework (introduced above) can smooth the performance of research projects and reduce the need for a "reinvention of the wheel" process. Nevertheless, they argue that a strong degree of experiential, project-specific learning is still necessary given the context-specificity of interdisciplinarity. But far from eliminate the possibility of professional learning in interdisciplinary collaboration, this simply suggests its needs to be oriented towards experience and reflection, as well as high level guidance and frameworks, of the sort many academics are accomplished in. It also highlights the valuable role of those with "craft expertise" in interdisciplinarity. Siedlok et al. (2014) found that having people who are 'good at IDR' can help enable and inspire others in an organisation to engage in interdisciplinarity, especially when they are connected through an emerging 'community of practice', as informal as such a network may be.

It is pertinent to consider the strengths and weaknesses of the ISG approach. For, just as researchers need to '*learn to pick the winners*', as one researcher remarked about prioritising interdisciplinary project opportunities, so too do research managers - and they need to pick the winning mechanism for picking winners. The first

Table 7: Desired support for IDR: researchers' recommendations

Direct funding of IDR	Other specific support for IDR	General organisational systems
- Increase the amount available across the University - Fund at a higher level - Fund longer-term projects to allow them to develop a greater degree of interdisciplinarity - Diversify funding support mechanisms for IDR (e.g. any-time research grants, publication support, multimedia support, exhibition activities, event development, cross-disciplinary conference attendance, travel support) - Demonstrate consistent support for IDR so researchers can orient their research towards it with confidence - Demonstrate long-term commitment to the Research Institutes so researchers can invest time in them with confidence	- Create forums to allow interested researchers to meet - Foster network/community of practice of researchers interested in IDR - Searchable database of IDR research projects (underway, completed) - Searchable database of researchers interested in IDR - Workshops to bring together researchers around a broad theme - Run workshops and other professional development around doing IDR - Showcase/publicise success cases (videoed events, website, interviews) - Create a journal for and on interdisciplinary research - Create a scheme to connect student and academic work on IDR - Better connect seminar and lecture series between faculties - Offer interdisciplinary PhD scholarships - Increase accountability and tracking of IDR projects - University-wide survey of IDR activities and attitudes - Encourage and enable greater involvement from HASS researchers	- Provide specific incentives and time allowances for IDR in the PDF - Recognise and reward within-academia ID collaboration and partnerships as equivalent to community, industry and government engagement - Remove resource lumping in accounting; allow for fair and easy budget flows between faculties - Mandate that all equipment and data purchased on an IDR grants is owned by University at large and is accessible to researchers from other faculties during and beyond the duration of the grant - Remove reward impediments to cross-disciplinary co-supervision of RHD students - Streamline the process of drawing up agreements with industry and ensure it occurs in a timely manner - Work to reform the Field of Research Code system and discipline-specificity of granting bodies - Increase collaboration and decrease competition between the Research Institutes; give them a greater role in collectively fostering IDR

question to ask if how a seed funding scheme compares to other options. While analysis of this is beyond the scope of this report, it is useful to consider the recent study by Siedlok et al. (2014), which identifies a range of interdisciplinary practices at the individual, small group and (organisational) community levels that resonate with many of the issues identified in this report (Figure 9). They also analyse the extent to which these practices

are fostered by certain institutional interventions. While they do not consider seed funding *per se* among their interventions, it is clear that a scheme such as the ISG program operates primarily to facilitate interdisciplinarity at the small group level, which fosters what Siedlok et al. (2014) call 'practices of engagement'. This leaves scope for other interventions to foster interdisciplinarity at the individual level (e.g.'new joiner meetings' and 'university research days') and the community/institution (e.g. 'Dragon's dens' (a high profile competition across the organisational to pitch interdisciplinary ideas for funding)). The participant feedback relayed above suggests there is an appetite among researchers for more of both such strategies, as well as ongoing support for small group interdisciplinary research.

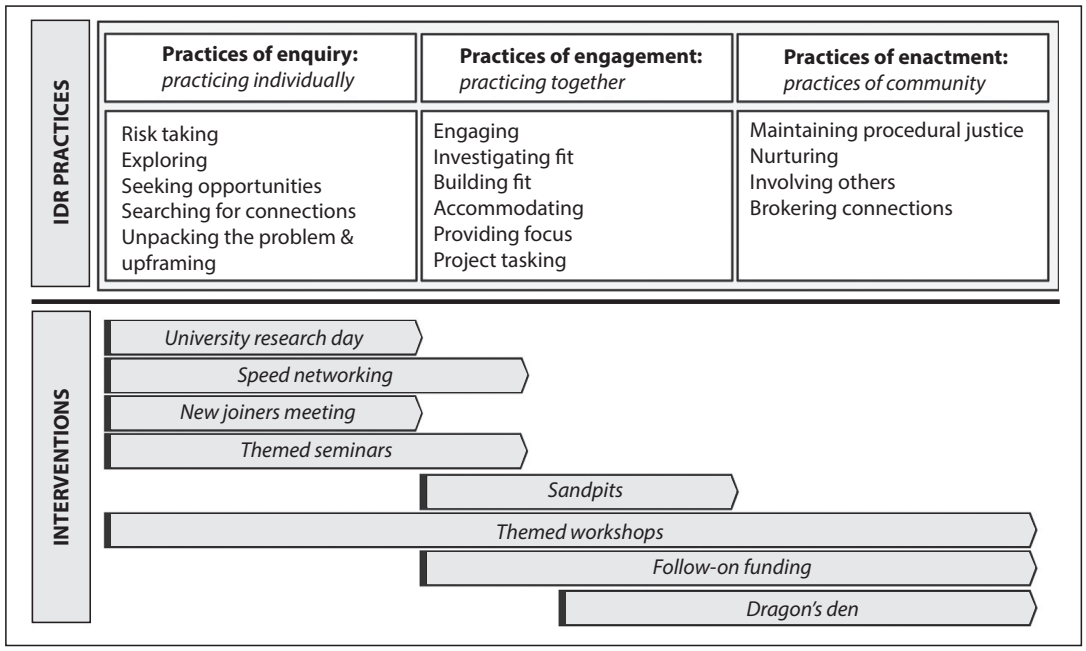


Figure 9: The contribution of different institutional interventions in encouraging different levels of interdisciplinary practice (Siedlok et al. 2014).

The second question to ask is, in taking a seed funding approach, how does the ISG compare to recommended practice? Insight into this is provided by comparing it to the type of funding identified by (Laudel and Gläser 2014) as conducive to 'breakthrough research' of the sort sought by the ISG program. To begin with, the scheme aligns well with the sort of "risk tolerance" recommended by authors, especially given the current climate of pragmatism and organisational triage in Australian academia, in which concentrations of institutional capital exert ever greater gravitational pull on the dwindling flow of resources[27]. The ISG program also ar-

[27]The so-called 'Matthew effect', phenomenon of cumulative advantage or triage logic identified by Robert Merton in which those who seem most self-reliant (strongest) tend to attract the most support (Merton, Robert K. 1968. "The Matthew effect in science." Science 159(3810):56-63.

guably fulfils another recommended characteristic which is 'flexibility of standards governing project selection'. It does not compare so well on the other criteria: a high amount of funding; a long duration of funding; and a flexible budget structure (to the extent that ISG funding is delivered through the existing faculty accounting system). According to the authors, these characteristics lower the ability of funding schemes to support projects involving: complex task-specific equipment and approaches; uninterrupted research time; long time horizons; and an environment tolerant of intellectual diversity (that is, ideas that go against the grain). For such research - which potentially blends longer-term small group interdisciplinary practices into larger scale community-level interdisciplinarity of the sort discussed by Siedlok et al. (2014) - more time and support and system flexibility is needed. The same could no doubt be said for the organisational leaders charged with addressing such needs and constructing winning support measures in the context of their own immense pressures and constraints. But they are not on their own. As the University engages in its own project of discovery, it has a diversity of bright minds in its midst. This includes those involved in the ISG program, who were overwhelmingly positive about the scheme, as described above and in Table 8 below, which illustrates some of the many statements of thanks offered up.

Table 8: Example statements of support for the ISG program offered by participants in the survey

Thank you for this funding that made so much difference to our project.
Thanks for the seeding grant!
This project has been a stimulating pleasure to work on.
Participating in this research project was a great experience.
Keep funding it please!
More seed funding! Seed funding availability is crucial for our grant applications
This has been a superb experience, thank you.
An excellent initiative to encourage collaboration across disciplines, thank you.
Please continue this.
Thanks for the support, it is much appreciated.

5 Conclusion

In conclusion, this report suggests that interdisciplinary collaboration is a highly valued and valuable aspect of the University, leading to a wide array of beneficial outcomes to date and an expansive realm of potential outcomes to come. Academics participate in interdisciplinary collaboration for numerous reasons and to varying degrees, with some dipping in on an *ad hoc* basis and with others fully focused on it. Understanding academics' perceptions and experiences of interdisciplinary research projects - and the promises and pitfalls of such collaborations more generally - requires seeing their projects as highly particular and dynamic meeting points between individuals' overlapping career trajectories. The peculiarities of unique research projects stem as much from the related interpersonal factors as cognitive or topic-based ones. Strong commonalities also exist such as a concern with producing academic outputs, challenges in doing so in a way of mutual benefit to those involved, an instinctual rather than formal approach to managing the group process. It is also apparent that besides the generally positive feel to the ISG scheme it remains something of an anomaly and that there is a need for further critical analysis of how interdisciplinarity sits within the University. This brings us back to the question of the broad institutional logics or agendas at work in the University (productivity, excellence and impact). It is well known that these agendas, plus individuals' strategic responses for subverting and coping with them, tend to encourage individuals' to engage in research collaboration, at least in the STEM and social sciences (Lewis 2013; Siedlok and Hibbert 2014). Results from this MICE project further suggest that they send very mixed messages about interdisciplinarity. Although virtually all researchers positioned their work in relation to these institutional drivers and related incentives, whether any one logic was considered to encourage or discoursage interdisciplinarity varied[28]. For, as the literature suggests (e.g. Buanes and Jentoft 2009; Hicks et al. 2010; Siedlok and Hibbert 2014), existing incentivisation towards interdisciplinarity is far from straight-forward or fully enabling. Besides explicit encouragement of interdisciplinarity such as the ISG scheme, multiple other, arguably stronger, signals prevail. Although for the participants in this research project these countervailing forces have obviously not prevented them from doing interdisciplinary research - with them instead recognising and choosing to follow the opportunities presented by it (including the seed funding) - they are not immune from them.

The resultant tension produces the risk that, as Siedlok and Hibbert (2014) suggest, the interdisciplinarity that is conducted is more superficial than that which could be achieved were the pressures upon people's time management, budgets, research trajectory and career choices etc. less acute and more favourable to interdisciplinarity. The point of considering this risk is not to revive the multi- versus inter-disciplinary debate, advocate for a certain model of interdisciplinary research, or to assess the quality of the interdisciplinary research conducted by participants in this study. Rather it is to heed the candid observations from the participants themselves about the institutional context in which they conduct interdisciplinary research, which strongly suggest that many feel under pressure to moderate their personal commitment to it and to any given interdisciplinary research project in particular. Combined with the challenges of doing group-based interdisciplinarity well, plus the inevitable 'violence' (as one interviewee phrased it) involved in pulling a research project to a conclusion, this raises the risk that the quality of the interdisciplinary knowledge being produced is compromised.

[28] It is possible that this positioning is post hoc and an artefact of the interview and survey process more than a conscious driver of their research choices.

In a sense the challenges of time pressure etc. differ little from what could be said of any research project. But such pragmatic realities have particular political overtones and institutional implications for interdisciplinary research. It is conceivable that such pressures feed back to the institution and sector in a way that reduces the visibility, and professional appeal of doing, interdisciplinary research. Six potential feedbacks can be hypothesised. One, a superficial approach to interdisciplinarity within a project could reduce how much those involved enjoy it, encouraging the rapid disintegration of the research group at the project's end, reducing individuals' propensity to either collaborate on the same topic again or in an interdisciplinary way again. Two, individuals may gain less intellectual benefit from the project, reducing the new knowledge or insights they have to share with their disciplinary or departmental peers, and thus limiting opportunities for broader learning or the showcasing of interdisciplinarity to those unfamiliar with it. Three, a mechanical or "rushed" approach to interdisciplinarity could become normalised, worsening the other feedbacks and discouraging learning about how to do interdisciplinarity well. Four, the existence of any epistemological conflicts could be occluded or glossed over. This could encourage the unthinking adoption of a positivist model of interdisciplinarity when other more dialogical modes may be more appropriate. In turn, this could reduce the quality of the knowledge produced, may limit how appealing interdisciplinarity is to those from non-positivist traditions, and neglects the need to increase awareness of the existence of other epistemologies or conceptions of interdisciplinarity. Five, as a result of the above, interdisciplinarity could continue to lag institutionally and the forces militating against it remain unchallenged. Six, cultural enthusiasm for interdisciplinarity could remain patchy or a mere form of tolerance, discouraging in-depth discussion or celebration of it.

Results from this project suggest that the first (and to a lesser extent, second) of these risks are not evident at the University, with a striking enthusiasm expressed about continuing the research directions and collaborations. Nevertheless, there are signs that the other 4-5 risks are reflected in the situation in the University to some degree. There seems to be an opportunity for the University and Academy to move to a more mature engagement with interdisciplinarity, shifting the focus away from an agnostic zero-sum focus on whether "it" is being "done" or not, or how many heads are involved, to a greater appreciation of its diverse but patterned forms, what interdisciplinarity involves, and cultivation of not just disparate projects but the organisational and career context in which they exist. Through deeper engagement with the qualitative aspects of interdisciplinarity and with the practical, political and philosophical issues involved (of the sort flagged in this report), the University could become a leader in developing a more sophisticated, transparent, durable and inclusive approach to interdisciplinarity, improving our understanding of the world at multiple levels.

Recommended reading

On interdisciplinary research experiences

- Harris, F., F. Lyon and S. Clarke (2009). "Doing interdisciplinarity: motivation and collaboration in research for sustainable agriculture in the UK." Area 41(4): 374-384.
- Shrimpton, B. and B. Astbury (2011). "Motivations for doing Interdisciplinary Research: Results from an Australian Qualitative Study." The International Journal of Interdisciplinary Social Sciences 6: 195-206.
- Webber, M (2013). "The character of interdisciplinary research. Examined through a sample of socio-environmental research projects". Report for the Australian Council of Learned Academies, www.acola.org.au

On the philosophical and political challenges

- Gardner, S. K. (2013). "Paradigmatic differences, power, and status: a qualitative investigation of faculty in one interdisciplinary research collaboration on sustainability science." Sustainability Science 8(2): 241-252.
- Mauthner, N. S. and A. Doucet (2008). "'Knowledge once divided can be hard to put together again': An epistemological critique of collaborative and team-based research practices." Sociology 42(5): 971-985.
- Phoenix, C., N. J. Osborne, C. Redshaw, R. Moran, W. Stahl-Timmins, M. H. Depledge, L. E. Fleming and B. W. Wheeler (2013). "Paradigmatic approaches to studying environment and human health: (Forgotten) implications for interdisciplinary research." Environmental Science & Policy 25(0): 218-228.

Guidance on doing interdisciplinary research

- Bammer, G. (2012). Disciplining interdisciplinarity: integration and implementation sciences for researching complex real-world problems, ANU E Press.
- Bozeman, B. (2014). Research Collaboration and Team Science: A State-of-the-art Review and Agenda. London, Springer.
- Petts, J., S. Owens and H. Bulkeley (2008). "Crossing boundaries: Interdisciplinarity in the context of urban environments." Geoforum 39(2): 593-601.

On institutional support for interdisciplinarity

- Bozeman, B., D. Fay and C. P. Slade (2013). "Research collaboration in universities and academic entrepreneurship: the-state-of-the-art." The Journal of Technology Transfer 38(1): 1-67.

- Siedlok, F. and P. Hibbert (2014). "The Organization of Interdisciplinary Research: Modes, Drivers and Barriers." International Journal of Management Reviews 16(2): 194-210.
- Townsend, T., J. Pisapia and J. Razzaq (2013). "Fostering interdisciplinary research in universities: a case study of leadership, alignment and support." Studies in Higher Education(ahead-of-print): 1-18.

On the modern academic context

- Brew, A. and L. Lucas (2009). Academic Research and Researchers. London, McGraw-Hill International.
- Lewis, J. (2013). Academic Governance: disciplines and policy. New York, Routledge.

Cited references

Abelson, J, Blacksher, E A, Li, K K, Boesveld, S E & Goold, S D 2013 Public Deliberation in Health Policy and Bioethics: Mapping an emerging, interdisciplinary field. Journal of Public Deliberation 9 5.

Aram, J D 2004 Concepts of interdisciplinarity: Configurations of knowledge and action. Human Relations 57 379-412.

Archer, L 2008a The new neoliberal subjects? Young/er academics' constructions of professional identity. Journal of Education Policy 23 265-85.

Archer, L 2008b Younger academics' constructions of 'authenticity', 'success' and professional identity. Studies in Higher Education 33 385-403.

Barry, A & Born, G 2013 Interdisciplinarity: reconfigurations of the social and natural sciences. in Barry, A & Born, G eds Interdisciplinarity: reconfigurations of the social and natural sciences. Routledge, London.

Barry, A, Born, G & Weszkalnys, G 2008 Logics of interdisciplinarity. Economy and Society 37 20-49.

Bartkus, V O & Davis, J H 2010 Social capital: Reaching out, reaching in Edward Elgar Publishing.

Becher, T 1989 Academic Tribes and Territories: intellectual enquiry and the cultures of disciplines Open University Press and the Society for Research into Higher Education, Buckingham.

Bestelmeyer, B T & Briske, D D 2012 Grand challenges for resilience-based management of rangelands. Rangeland Ecology & Management 65 654-63.

Billot, J 2010 The imagined and the real: identifying the tensions for academic identity. Higher Education Research & Development 29 709-21.

Bozeman, B, Fay, D & Slade, C P 2013 Research collaboration in universities and academic entrepreneurship: the-state-of-the-art. The Journal of Technology Transfer 38 1-67.

Brew, A & Boud, D 2009 Understanding academics' engagement with research in Brew, A & Lucas, L eds Academic Research and Researchers: Policy and Practice. McGraw-Hill Education, Maidenhead.

Briggs, A R 2007 Exploring professional identities: middle leadership in further education colleges. School Leadership and Management 27 471-85.

Buanes, A & Jentoft, S 2009 Building bridges: Institutional perspectives on interdisciplinarity. Futures 41 446-54.

Burawoy, M 2005 For Public Sociology. American Sociological Review 70 4-28.

Cantwell, R H & Scevak, J J 2010 An academic life: a handbook for new academics Aust Council for Ed Research.

Carter, E D & Housel, J 2013 Stand-Alone Geographers in the North American Academy: A Survey of Perceptions and Concerns. The Professional Geographer 65 230-46.

Castle, E N 2002 Social Capital: An Interdisciplinary Concept*. Rural Sociology 67 331-49.

Chaturvedi, V 2012 Mapping Subaltern Studies and the Postcolonial Verso Books, London.

Cooper, G 2013 A disciplinary matter: critical sociology, academic governance and interdisciplinarity. Sociology 47 74-89.

Cornell, S 2010 Brokering interdisciplinarity across the physical and social sciences. Interdisciplinarity and Climate Change: Transforming Knowledge and Practice for Our Global Future 116.

DeLyser, D & Sui, D 2012 Crossing the qualitative-quantitative divide II: Inventive approaches to big data, mobile methods, and rhythmanalysis. Progress in Human Geography.

DeLyser, D & Sui, D 2014 Crossing the qualitative-quantitative chasm III: Enduring methods, open geography, participatory research, and the fourth paradigm. Progress in Human Geography 38 294-307.

Derry, S J, Schunn, C D & Gernsbacher, M A 2013 Interdisciplinary Collaboration: An emerging cognitive science Psychology Press, London.

Diezmann, C & Grieshaber, S 2013 Australian Women in the Academy. in Patton, W ed Conceptualising Women's Working Lives. SensePublishers.

Fogelberg, H & Lundqvist, M A 2013 Integration of academic and entrepreneurial roles: The case of nanotechnology research at Chalmers University of Technology. Science and Public Policy 40 127-39.

Frodeman, R 2011 Interdisciplinary research and academic sustainability: managing knowledge in an age of accountability. Environmental Conservation 38 105-12.

Frodeman, R & Mitcham, C 2007 New Directions in Interdisciplinarity: Broad, Deep, and Critical. Bulletin of Science, Technology & Society 27 506-14.

Garbett, D & Tynan, B 2010 A lifeline for emerging academics. RH Cantwell & J. J. Scevak (Eds.), An academic life 173-81.

Gardner, S K 2013 Paradigmatic differences, power, and status: a qualitative investigation of faculty in one interdisciplinary research collaboration on sustainability science. Sustainability Science 8 241-52.

Garrett-Jones, S, Turpin, T & Diment, K 2013 Careers and organisational objectives: managing competing interests in cooperative research centres. Cooperative Research Centers and Technical Innovation. Springer.

Gill, R 2013 17 Breaking the silence. Secrecy and Silence in the Research Process: Feminist Reflections 228.

Goodman-Delahunty, J & Walker, B 2010 Academic life: An interpersonal dimension. An Academic Life: A Handbook for New Academics 160-72.

Goring, S J, Weathers, K C, Dodds, W K, Soranno, P A, Sweet, L C, Cheruvelil, K S, Kominoski, J S, Rüegg, J, Thorn, A M & Utz, R M 2014 Improving the culture of interdisciplinary collaboration in ecology by expanding measures of success. Frontiers in Ecology and the Environment 12 39-47.

Granovetter, M S 1973 The strength of weak ties. American Journal of Sociology 78 1360-80.

Griffin, G, Green, T & Medhurst, P 2005 The relationship between the process of professionalization in academe and interdisciplinarity: a comparative study of eight European countries. University of Hull, http://www. york. ac. uk/res/researchintegration /comparativeReports/Comparative_Report_Professional ization_and _Interdisciplinarity. pdf.

Hansson, B 1999 Interdisciplinarity: For what purpose? Policy Sciences 32 339-43.

Harris, C, Ravenswood, K & Myers, B 2013 Glass slippers, Holy Grails and Ivory Towers: gender and advancement in academia. Labour & Industry: a journal of the social and economic relations of work 23 231-44.

Head, B W & Alford, J 2013 Wicked problems: implications for public policy and management. Administration & Society 0095399713481601.

Hemmings, B 2011 Sources of research confidence for early career academics: a qualitative study. Higher Education Research & Development 31 171-84.

Hicks, C C, Fitzsimmons, C & Polunin, N V C 2010 Interdisciplinarity in the environmental sciences: barriers and frontiers. Environmental Conservation 37 464-77.

Hoffman, D M 2009 Changing Academic Mobility Patterns and International Migration What Will Academic Mobility Mean in the 21st Century? Journal of Studies in International Education 13 347-64.

Holbrook, J B 2013 What is interdisciplinary communication? Reflections on the very idea of disciplinary integration. Synthese 190 1865-79.

Illouz, E 2013 Cold intimacies: The making of emotional capitalism John Wiley & Sons.

Ison, R 2010 Systems Practice: How to act in a climate change world Springer, and The Open University, London.

Jacob, M & Meek, V L 2013 Scientific mobility and international research networks: trends and policy tools for promoting research excellence and capacity building. Studies in Higher Education 38 331-44.

Jacobs, J A & Frickel, S 2009 Interdisciplinarity: A critical assessment. Annual Review of Sociology 35 43-65.

James, N 1989 Emotional labour: skill and work in the social regulation of feelings. The Sociological Review 37 15-42.

Joignant, A, Perello, L & Torres, J 2014 6 Political capital and the unequal career origins of the political elite in Chile1. Political Inequality in the Age of Democracy: Cross-national Perspectives 87.

Jones, P & Macdonald, N 2007 Getting it wrong first time: building an interdisciplinary research relationship. Area 39 490-98.

Kandiko, C B & Blackmore, P 2008 Institutionalising Interdisciplinary Work in Australia and the UK. Journal of Institutional Research 14 9.

Kellert, S H 2009 Borrowed knowledge: Chaos theory and the challenge of learning across disciplines University of Chicago Press.

Kessel, F., Rosenfeld, P. L. & Anderson, N. B. eds 2003 Expanding the Boundaries of Health and Social Science: Case Studies in Interdisciplinary Innovation. Oxford University Press, New York.

Kingdon, J W 1984 Agendas, Alternatives, and Public Policies Little, Brown, Boston.

Kisfalvi, V & Maguire, S 2011 On the Nature of Institutional Entrepreneurs: Insights From the Life of Rachel Carson. Journal of Management Inquiry 20 152-77.

Klein, J T 2010 A taxonomy of interdisciplinarity. in Frodeman, R ed The Oxford Handbook of Interdisciplinarity. Oxford University Press, Oxford.

Knights, D & Clarke, C A 2014 It's a bittersweet symphony, this life: fragile academic selves and insecure identities at work. Organization Studies 35 3 335-357.

König, B, Diehl, K, Tscherning, K & Helming, K 2013 A framework for structuring interdisciplinary research management. Research Policy 42 261-72.

Kostoff, R N 2002 Overcoming Specialization. BioScience 52 937-41.

Krishnan, A 2009 What are Academic Disciplines? Some Observations on Disciplinarity vs Interdisciplinarity Debate. ESRC National Centre for Research Methods: NCRM Working Paper Series. Working Paper Series March.

Krohn, W 2011 Interdisciplinary cases and disciplinary knowledge. in Frodeman, R ed The Oxford Handbook of Interdisciplinarity. Oxford University Press, Oxford.

Larner, W 2014 Globalising knowledge networks: Universities, diaspora strategies, and academic intermediaries. Geoforum.

Laudel, G & Gläser, J 2014 Beyond breakthrough research: Epistemic properties of research and their consequences for research funding. Research Policy 43 7 1204-1216.

Lefroy, T, Curtis, A, Jakeman, A & McKee, J 2012 Landscape Logic.

Leitch, C M, McMullan, C & Harrison, R T 2013 The development of entrepreneurial leadership: The role of human, social and institutional capital. British Journal of Management 24 347-66.

Lélé, S & Norgaard, R B 2005 Practicing Interdisciplinarity. BioScience 55 967-75.

Lewis, J 2013 Academic Governance: disciplines and policy Routledge, New York.

Lowe, P & Phillipson, J 2009 Barriers to research collaboration across disciplines: scientific paradigms and institutional practices. Environment and planning. A 41 1171.

Lubchenco, J 1998 Entering the Century of the Environment: A New Social Contract for Science. Science 279 491-97.

Lyall, C, Bruce, A, Marsden, W & Meagher, L 2013 The role of funding agencies in creating interdisciplinary knowledge. Science and Public Policy 40 62-71.

Lyall, C & Fletcher, I 2013 Experiments in interdisciplinary capacity-building: The successes and challenges of large-scale interdisciplinary investments. Science and Public Policy 40 1-7.

Lynch, A H, Tryhorn, L & Abramson, R 2008 Working at the boundary - Facilitating interdisciplinarity in climate change adaptation research. Bulletin of the American Meteorological Society 89 169-+.

Maadad, N & Tight, M 2014 Academic mobility Emerald Group Publishing.

MacMynowski, D P 2007 Pausing at the Brink of Interdisciplinarity: Power and Knowledge at the Meeting of Social and Biophysical Science. Ecology and Society 12 Article 20.

Malcolm, J & Zukas, M 2009 Making a mess of academic work: experience, purpose and identity. Teaching in Higher Education 14 495-506.

Manathunga, C 2009 Post-colonial perspectives on interdisciplinary researcher identities. in Brew, A & Lucas, L eds Academic Research and Researchers McGraw-Hill Education, Maidenhead, UK.

Marginson, S 2011 Higher Education and Public Good. Higher Education Quarterly 65 411-33.

Mauthner, N S & Doucet, A 2008 'Knowledge once divided can be hard to put together again': An epistemological critique of collaborative and team-based research practices. Sociology-the Journal of the British Sociological Association 42 971-85.

McAlpine, L 2012 Academic Work and Careers: Relocation, Relocation, Relocation. Higher Education Quarterly 66 174-88.

McSweeney, K & Coomes, O T 2011 Climate-related disaster opens a window of opportunity for rural poor in northeastern Honduras. Proceedings of the National Academy of Sciences 108 5203-08.

Merton, R K 1968 The Matthew effect in science. Science 159 56-63.

Meyer, M 2010 The rise of the knowledge broker. Science Communication 32 118-27.

Miller, C 2010 Policy challenges and institutional reform. in Frodeman, R, Klein, J T & Mitcham, C eds The Oxford Handbook of Interdisciplinarity. Oxford University Press, Oxford.

Nissani, M 1997 Ten cheers for interdisciplinarity: The case for interdisciplinary knowledge and research. The Social Science Journal 34 201-16.

Oughton, E & Bracken, L 2009 Interdisciplinary research: framing and reframing. Area 41 385-94.

Pallett, H & Chilvers, J 2014 Organizations in the making: Learning and intervening at the science- policy interface. Progress in Human Geography.

Pelling, M, High, C, Dearing, J & Smith, D 2008 Shadow spaces for social learning: a relational understanding of adaptive capacity to climate change within organisations. Environment and Planning A 40 867-84.

Peterson, V V 2009 Against interdisciplinarity. Women and Language 31.

Pettman, J J & Jan, P 1992 Living in the margins: Racism, sexism and feminism in Australia Allen & Unwin Sydney.

Pharo, E & Bridle, K 2011 Does Interdisciplinarity Exist Behind the FaՈade of Traditional Disciplines? A Study of Natural Resource Management Teaching. Journal of Geography in Higher Education 36 65-80.

Rambur, B 2009 Creating collaboration: an exploration of multinational research partnerships. in Brew, A & Lucas, L eds Academic Research and Researchers McGraw-Hill Education, Maidenhead, UK.

Reid, W, Chen, D, Goldfarb, L, Hackmann, H, Lee, Y, Mokhele, K, Ostrom, E, Raivio, K, Rockstr"om, J & Schellnhuber, H 2010 Earth system science for global sustainability: Grand challenges. Science(Washington) 330 916-17.

Reisberg, L & Rumbley, L E 2014 Redefining Academic Mobility: From the Pursuit of Scholarship to the Pursuit of Revenue. The Forefront of International Higher Education. Springer.

Reisinger, A 2011 Interdisciplinarity: are we there yet? Climatic Change 108 23-30.

Rhoten, D, O'Connor, E & Hackett, E J 2009 The act of collaborative creation and the art of integrative creativity: originality, disciplinarity and interdisciplinarity. Thesis Eleven 96 83- 108.

Rhoten, D & Parker, A 2004 Risks and rewards of an interdisciplinary research path. Science 306 2046-46.

Ross, F 2009 Degrees of disciplinarity in comparative politics: interdisciplinarity, multidisciplinarity and borrowing. European Political Science 8 26-36.

Sa, C M 2008 'Interdisciplinary strategies' in U.S. research universities. Higher Education 55 16.

Seeber, M & Lepori, B 2014 The internationalization of European higher education institutions. Knowledge, Diversity and Performance in European Higher Education: A Changing Landscape. Edward Elgar, Cheltenham, UK.

Serenko, A & Bontis, N 2013 Investigating the current state and impact of the intellectual capital academic discipline. Journal of Intellectual Capital 14 476-500.

Sergi, B, Parker, R & Zuckerman, B 2014 Support for international collaboration in research: The role of the overseas offices of basic science funders. Review of Policy Research 31 430-53.

Sheltzer, J M & Smith, J C 2014 Elite male faculty in the life sciences employ fewer women. Proceedings of the National Academy of Sciences 111 10107-12.

Sibley, D 1995 Geographies of exclusion: Society and difference in the West Psychology Press.

Siedlok, F & Hibbert, P 2014 The organization of interdisciplinary research: modes, drivers and barriers. International Journal of Management Reviews 16 194-210.

Siedlok, F, Hibbert, P & Sillince, J 2014 From practice to collaborative community in interdisciplinary research contexts. Research Policy.

Smith, J 2013 Geography in public and public geography: past, present and future. The Geographical Journal 179 188-92.

Smith, K 2012 Fools, Facilitators and Flexians: Academic Identities in Marketised Environments. Higher Education Quarterly 66 155-73.

Sperling, M & Karst, U 2013 Metallomics: an emerging interdisciplinary science. Analytical and bioanalytical chemistry 405 1789-90.

Star, S L & Griesemer, J R 1989 Institutional ecology, translations and boundary objects: amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907-1939. Social Studies of Science 19 387-420.

Sui, D & DeLyser, D 2012 Crossing the qualitative-quantitative chasm I. Progress in Human Geography 36 111-24.

Tight, M 2014 Theory Development and Application in Higher Education Research: Tribes and Territories. Higher Education Policy.

Tynan, B R & Garbett, D L 2007 Negotiating the university research culture: collaborative voices of new academics. Higher Education Research & Development 26 411-24.

van Rijnsoever, F J & Hessels, L K 2010 Factors associated with disciplinary and interdisciplinary research collaboration. Research Policy 10.

Webber, M 2013 The character of interdisciplinary research. Examined through a sample of socio-environmental research projects. Report for the Australian Council of Learned Academies, www.acola.org.au

Wenger, E 1998 Communities of practice: Learning, meaning, and identity Cambridge university press.

Winter, R P & O'Donohue, W 2012 Academic identity tensions in the public university: which values really matter? Journal of Higher Education Policy and Management 34 565-73.

Appendix A

Research institutes and their thematic foci:

- Bio21 Molecular Science and Biotechnology Institute (Bio21)
  - Structural Biology
  - Chemical Biology
  - Nanobiotechnology
- Institute for a Broadband Enabled Society (IBES)
  - Business & Government
  - Culture & Community
  - Education & Learning
  - Health & Ageing
- Melbourne Energy Institute (MEI)
  - Energy production
  - Energy distribution and consumption
  - Economics and policy
- Melbourne Materials Institute (MMI)
  - Materials conservation
  - Materials for medicine
  - Quantum and nanophotonic materials
  - Materials for energy
  - Materials processing
- Melbourne Neuroscience Institute (MNI)
  - Centre for Neural Engineering
  - Music, Mind & Wellbeing
  - Stem Cells Australia
  - Melbourne Brain Centre Imaging Unit
- Melbourne Social Equity Institute (MSEI)
  - Access to Public Goods
  - Citizenship and Diversity
  - Human Rights
  - Social Policy across the Life Course
- Melbourne Sustainable Society Institute (MSSI)
  - Climate Transformations
  - Future Cities / Urban Futures
  - Sustainability in the Anthropocene