As Humpty Dumpty said to Alice – when I use a word … it means just what I choose it to mean – neither more nor less (Carroll, 269)

Abstract
The differentiation of forms of interdisciplinarity, each of which has merit, is a critical first step in responding to the challenges these crossings pose to traditional institutional structures. The relevance of the 21st Century university may depend on its ability to innovate institutionally.

1.0 Introduction
Interdisciplinarity as a form of practice and, as an area of scholarly research is not new. An authoritative overview of this subject and its origins can be found in UNESCO (1982), and Klein (1990; 1996). Interdisciplinarity became re-invigorated in the 1960s in response to the increased specialisation evident in the disciplines combined with a growing awareness that the complex and interconnected nature of so many contemporary problems required multiple perspectives. Climate change, the potential for a new pandemic, or the recent breakdown of the world financial system are all wicked problems (Rittel, 1973); problems about which there is considerable uncertainty and ambiguity, and problems for which there is no ‘right’ answer – only better or worse solutions. Defining the problem is part of the problem and it’s an advantage to have diverse perspectives and different ways of thinking. Even less severely constrained problems – problems that are merely ‘hard’ as opposed to wicked – may also benefit from more systemic approaches and integrative thinking. New technologies, in particular, internet technologies and the global information network they enable, provide access to information on an unprecedented scale and make possible global collaborations which further increases complexity. Facilitating Interdisciplinary Research, a report of the U.S. Committee on Science, Engineering, and Public Policy summaries the rise

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of interdisciplinarity as follows: “Interdisciplinary thinking is rapidly becoming an integral feature of research as a result of four powerful “drivers”: the inherent complexity of nature and society, the desire to explore problems and questions that are not confined to a single discipline, the need to solve societal problems, and the power of new technologies” (2005, p.40). The US Council of Graduate Schools in a 2007 report called for an increase in interdisciplinary training stating that: “interdisciplinary research preparation and education are central to future competitiveness, because knowledge creation and innovation frequently occur at the interface of disciplines” (2007, p.18). Given the importance ascribed to this form of research and the centrality of research in the university, this paper considers the challenges interdisciplinarity raises for the traditional university and argues for the need for reform. Complex problems, however, also reveal the epistemological limits of interdisciplinarity, \(^1\) and the step is to differentiate between the popular use of the term interdisciplinary and its technical meaning. We can then define other forms of disciplinary crossings that are often assumed under this general term and explore the institutional challenges posed by each form.

2.0 (Re)defining Interdisciplinarity

Interdisciplinarity is the term most often used to describe activities in which individuals from two or more disciplines are engaged. Used this way the term not only masks what scholars generally agree constitutes this specific form of disciplinary crossing, but confines to the shadows other forms of disciplinary crossings that are fundamentally different. As Barthes notes in Jeunes chercheurs: “To do something interdisciplinary it's not enough to choose a subject (a theme) and gather round it two or three sciences. Interdisciplinary consists in creating a new object that belongs to no one.” (James,1986, p.598). The authors of Facilitating Interdisciplinary Research concur. Interdisciplinary research is defined as: “a mode of research by teams or individuals that integrates information, data, techniques, tools, perspectives, concepts, and/or theories from two or more disciplines or bodies of specialized knowledge to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline or field of research practice. Research is truly interdisciplinary when it is not just pasting two disciplines together to create one product but rather is an integration and synthesis of ideas and methods. An example is the current exploration of string theory by theoretical physicists and mathematicians, in which the questions posed have brought fundamental new insights both to mathematicians and to physicists” (2005, pp.26-27).

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In *Questioning Interdisciplinarity* Frodeman et al point out that this form of interdisciplinarity does little to address complex issues “as it leads ultimately only to more and more refined disciplinarity” (2000/2001, p.4). They propose two additional forms – *wide interdisciplinarity* involves crossings from across the sciences, social sciences and/or humanities and *deep interdisciplinarity* bridges the gap between the academy and the community. These two forms they argue, resolve the paradox that “in a century of interdisciplinary effulgence that each attempt at interdisciplinarity has tended to produce not any true understanding or counterpoint to specialization so much as the presentation of another imminent specialization” (2000/2001, pp.1,3). This suggestion has merit in that it not only opens a space for a range of disciplinary border crossings, but more significantly, acknowledges the need for reflexive engagement of social, humanistic and scientific practices, while not privileging any one way of knowing.

When the term interdisciplinary is used as a general descriptor it is not only misleading, but few projects achieve, or even aspire, to this form of disciplinary crossing. In fact, the motivation is precisely the opposite. The goal is to explore complex and often systemic issues from multiple perspectives where each discipline is relatively autonomous. The differentiation of *wide* and *deep* forms of interdisciplinarity helps to reveal this contradiction but more commonly used terms such as *cross-, trans- or multi-disciplinarity* better differentiate these forms of border crossings. The most significant difference among these forms is between *multidisciplinarity*, and *cross- or transdisciplinarity*. The *Facilitating Interdisciplinary Research* report describes *multidisciplinary* research as:

“research that involves more than a single discipline in which each discipline makes a separate contribution. Investigators may share facilities and research approaches while working separately on distinct aspects of a problem. For example, an archaeological program might require the participation of a geologist in a role that is primarily supportive. Multidisciplinary research often refers to efforts that are additive but not necessarily integrative” (2005, p. 27).

In the case of *transdisciplinarity*, Kockelmans (1979) suggests that the objective is to establish a common set of axioms for a set of disciplines. He describes *cross-disciplinarity* as work done by a team “who try to solve a problem or set of problems that no discipline in isolation can adequately deal with” (1979, p.128). These descriptions, however, are not sufficient to
differentiate these forms, nor to distinguish them from interdisciplinarity. What is masked is a key distinguishing feature of trans- or cross-disciplinarity\(^3\) – that is, its generative potential. Interdisciplinary work is always situated and in transdisciplinarity the primary focus is not on the discipline per se but on the generative potential of the interaction of individuals from different disciplines working together in the context of a specific problem or application. Diversity matters. The context matters. Figure 1 below shows this diagrammatically.

Figure 1: Multi-, inter- and transdisciplinary

It is this last type of crossing – transdisciplinarity that is the most radical both in the nature of the practice and in its outputs. It is this form that most directly challenges established academic norms about the ways in which knowledge is produced in the university.

3.0 The University as a Site of Knowledge Production

Universities, as institutions of higher learning and research are the traditional site of scientific, social and cultural knowledge production and a primary employer of scholars and researchers in the humanities, social sciences, physical and health sciences. Disciplines have been the way in which scholarship has been organised and within each discipline there are accepted norms and values around the production of knowledge. In the modern university disciplinary and departmental boundaries are virtually synonymous, and as departments regulate, evaluate and discipline this production through the administration of rewards systems such as promotion and tenure, it can be difficult to move outside. While practices vary across the university there is a shared understanding and set of norms for what constitutes a legitimate knowledge claim in any field, and how such

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claims should be supported, substantiated or validated. This is a further challenge for scholars participating in interdisciplinary activities who may have neither the history, nor the administrative structures in place to accommodate their practices, and they risk becoming isolated institutionally. While the social characteristics of knowledge production vary across the disciplines, the most successful practices institutionally have been in the sciences and in those disciplines that have adopted similar approaches to knowledge production. The scientific approach with its commitment to objectivity, experimental methods, measurement, and reproducible results has become the de facto standard by which the other disciplines are judged, and often found wanting. While most scholars, including scientists, have a more sophisticated and nuanced understanding today of the changes that have taken place across the intellectual landscape, especially since the late 1960s, the privileging of scientific thinking, ways of knowing and forms of knowledge production largely continues.

At the same time the relevance and value of various types of disciplinary crossings, as well as the merits of broad diverse participation have been more widely recognised. In The New Production of Knowledge, Michael Gibbons (1994) and his collaborators set out to explore major changes in the way knowledge was being produced across the disciplines. The organizing principle was “that a new form of knowledge production is emerging alongside the traditional, familiar one” (Gibbons,1994, p. vii). The attributes of this new form of knowledge production that distinguish it from the traditional form are the recognition that knowledge is produced in the context of application⁴ that it is transdisciplinary, collaborative, heterogeneous in terms of the skills people bring to it, reflexive and aware of the broader context and social accountability, and with new criteria to assess the quality of the outcomes (Gibbons, 1994, pp.3-11). While this thesis is not without its critics (Nowotny, 2003), nor is it entirely novel, their framing of the production of knowledge as a socially distributed knowledge production system in which knowledge is both supplied by and distributed to individuals and groups across the social spectrum (Gibbons, 1994, p.14) resonated with the experience of many researchers. It highlighted the transdisciplinary nature of much contemporary problem solving and located the production of knowledge in part outside the university.

⁴.0 (Re)forming Universities
A critical first step in responding to the institutional challenges such crossings pose to institutional structures grounded in traditional practices

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designed to (re)produce scholarly careers through traditional forms of knowledge production is the differentiation of the forms of interdisciplinarity, each of which has merit. **Interdisciplinary, multidisciplinary** and **transdisciplinary** projects and programs in the university tend to emerge out of a shared set of interests among a group of scholars. These may arise internally, or in response to external stimuli from government, or industry for example. Within the university, such projects and programs struggle to insert themselves into existing structures and it is here that the differences among the forms are revealed. Some interdisciplinary programs have successfully institutionalised – in particular the form of interdisciplinarity which leads to the development of new specialisations – e.g., cognitive science or women’s studies. In both cases these largely reproduce the well-understood apparatus of knowledge production. **Multidisciplinary** approaches are also minimally disruptive and do not require significant institutional reform to accommodate them as the participants continue to be part of their disciplinary culture. It is the **transdisciplinary** approaches that present the greatest challenge to the dominant mode of knowledge production – not because there are multiple disciplines involved, but because of the generative nature of the process and because the nature of the knowledge produced does not fit neatly into individual disciplinary categories or cultures. **Transdisciplinarity** disrupts traditional academic systems of accountability, evaluation and reward. At the same time, some form of evaluation is required to legitimate these practices in the university, and to enable wider participation in this type of research by faculty and graduate students. This is a complex challenge both for individuals and for the institution. On the one hand, those engaged in interdisciplinary practices need to shoulder some of the responsibility for developing an alternative evaluation scheme, and it is in their interest to do so. They have the expertise to enumerate what is most valuable in these new forms and to describe what constitutes success. However, this type of accounting activity is seldom of interest to researchers and scholars. On the other hand, unless there are senior administrators who recognise the innovative potential of various forms of interdisciplinarity there is little incentive for the university to undertake the development of schemes to accommodate and evaluate the outputs of these forms of research practice. While universities embrace innovation, it is generally in the limited way associated with scientific or technological developments that have the potential to be translated into financial returns. Less attention is paid to another type of innovation – **institutional innovation** – required to take interdisciplinary agendas forward. Too often the receptor capacity is not there, with the
result that new forms of knowledge production which are complementary, not competitive with existing practices, and increasingly understood to be a source of innovation, are not supported institutionally. Universities need to find ways of accommodating what may be one of the most dynamic, flexible and responsive parts of the institution – groups whose practice is grounded in teamwork and collaboration, who are in touch with their disciplinary depths yet bridge these differences to connect with the broader community. When interdisciplinarity in all its forms is not well accommodated, the university as an institution loses an important opportunity. We conclude this section with a brief examination of the emerging field of interaction design to illustrate the nature of the challenge.

There is “no commonly agreed definition of interaction design” according to Daniel Fallman, but at “its core can be found in an orientation toward shaping digital artifacts – products, services, and spaces – with particular attention paid to the qualities of the user experiences” (2008, p.4). As digital artifacts are increasingly embedded in all aspects of everyday life, there has been growing recognition of the importance of situating these developments in the context of use with a more nuanced understanding of the user experience and how technologies both shape and are shaped in interaction with those who use them. These ideas had first taken root in the late 1970s among some computer scientists and social scientists. Aware of the impact that the expansion of computers and technologies was having, initially in the workplace, they began to consider how technical artefacts might be created in ways that took seriously those who would eventually use them and the nature of their interactions with the technology and with other people. At the 1999 conference Researching Design: Designing Research Buchanan, elaborated on this from the perspective of design: “what I believe has changed in our understanding of the problem of design knowledge is greater recognition of the extent to which products are situated in the lives of individuals and in society and culture” (2001, p.14). Today, the emerging field of interaction design includes researchers from multiple disciplines as well as practitioners and industry members from outside the academy. While the potential of this diversity to inform research on interaction design is generally recognised, it does not fit comfortably within a single university department.

This situation is not unfamiliar in the traditional design disciplines which have long faced challenges to the legitimacy of their mode of knowledge production with its concern for the relationship between practice and research, a focus on ‘making’ as well as thinking, and collaborative
practices that recognise the need for negotiation, and distinguish problem setting from problem solving. As a result, design may help point the way forward and provide a home for interaction design in the traditional university. However, computer science, specifically the subfield of human-computer interaction, is also a contender, and CHI, the pre-eminent conference in this field added a design section to its annual conference in 2006. It is not clear how design can be accommodated in a primarily technical department with a well-defined set of practices and norms around knowledge production and a formal system for the distribution of rewards that maps to existing institutional structures. Opening computer science to this form of intellectual engagement challenges the status of the discipline at a fundamental level. Others argue that the way ahead is the establishment of interdisciplinary centres. As Buchanan observes some see “in the problems of design the need for new kinds of research for which there may not be entirely useful models in the past – the possibility of a new kind of knowledge, design knowledge for which we have no immediate precedents” (2001, pp. 6-7). Whatever route is taken, there is a challenge to the institution.

Despite the lack of a consistent or coherent institutional response to interaction design the field is continuing to grow. However, it is also clear that despite the opening up to alternative theoretical perspectives and new ideas about the nature of knowledge and ways of knowing, the scientific, rational accounts continue to be powerful in the contemporary university. Today, universities in general and public universities in particular, are experiencing increased pressure for accountability from the governments and agencies on which they depend financially. As well, they compete globally for students and faculty. One result is increased bureaucratisation and a passion for metrics – a situation that privileges the established disciplines in which boundaries are clearly defined and where the knowledge produced can be most easily quantified. In addition, the results of research in the natural, physical and engineering sciences are generally believed by senior administrators to be most relevant to industry and to have the greatest potential for commercialisation. But the world outside the academy is changing, and universities as institutions have been slow to respond.

5.0 Conclusion
Today, innovation and the fostering of creativity that drives it are understood to be strategic not only for the future of the university but for the
21st Century economy. For interdisciplinary research to flourish its various forms of research practice and knowledge production must be accommodated. Framing the institutional reform required as institutional innovation may highlight the creative, generative and integrative nature of these practices and make explicit the nature of the risk involved. If there is no risk to the institution, it is unlikely the response will be innovative. If there is no stability, interdisciplinarity initiatives are less likely to emerge. The need for (re)form is urgent as interdisciplinarity has the potential to re-invigorate the institution. As Casey observes: “Many universities and colleges today have a bureaucratic culture that assumes consensus and discounts controversy because it threatens organisational stability. Interdisciplinary leadership taps motivational bases and creates a climate in which risks can be taken and uncertainty and ambiguity are considered to be essential to the work that takes place” (1994, p. 66).

The relevance of the 21st century university will depend on its ability to find creative solutions to these challenges.

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1 In keeping with current practice, the term interdisciplinary (without italics) will be used to refer to disciplinary border crossings in general. When referring to specific forms, including interdisciplinary, the term will be italicised.
2 See Klein (2000) for further discussion.
3 Cross-disciplinarity is generally used more or less interchangeably with trans-disciplinarity in the literature. However, as a new literature is emerging around the term transdisciplinarity, it is the preferred term and will be the term used to discuss this form of crossing in this remainder of the paper.
4 This is not the same as “the process of application by which ‘pure’ science, generated in theoretical /experimental environments, is ‘applied’; any technology is ‘transferred’; and knowledge is subsequently ‘managed’. The context of application, in contrast, describes the total environment in which scientific problems arise, methodologies are developed, outcomes are disseminated, and uses are defined” (Nowotny, 2003, p.186).
5 This is a major reason that faculty engaged in various forms of interdisciplinarity, in particular, transdisciplinarity, can do so only after tenure and at some risk to their ‘disciplinary’ careers. Graduate students whose interests increasingly cross traditional boundaries may not be able to ‘afford’ to participate fully.
6 This refers to an organization's ability to absorb and apply research evidence
7 These typically include industrial design, graphic design, and architecture.
Interrogations: Gale Moore


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