

# THE STATE OF THE FIELD: Interdisciplinary Research

by

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**Abstract:** Our understanding of the process of interdisciplinary research has expanded considerably over the last decades. The purpose of this brief paper is to take stock of where we are and where we are going. The first section addresses definitional issues and discusses the relationship between teaching and research. The second section discusses potential objections to the idea of identifying best practices for interdisciplinary research. The third section outlines best practices for each step in the interdisciplinary research process, and identifies avenues for further research.

**Keywords:** interdisciplinary, research, process, best practices, definition, quality

Our understanding of the process of interdisciplinary research has expanded considerably over the last decades. The purpose of this brief article is to take stock of where we are and where we are going.

## On Defining Interdisciplinarity:

There is now a fair bit of consensus at least among scholars associated with AIS that interdisciplinarity<sup>1</sup> involves the integration of insights from multiple disciplines in order to better understand some complex topic that is addressed from different perspectives by different disciplines. Such a definition tells us a lot about what we are trying to accomplish, but very little

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<sup>1</sup> The definition here refers to what is commonly termed instrumental interdisciplinarity. There are also various forms of critical or conceptual interdisciplinarity that question the structure and role of disciplines.

about how we might do so. This state of affairs is unsurprising for two reasons. First, definitions generally address what more than how. In particular, most disciplines are defined in terms of what is studied rather than how. Second, as interdisciplinarians have struggled to comprehend interdisciplinarity over the years, it is hardly surprising that they have focused on what they were striving to achieve before they attempted to agree on how to get there.

I would argue that there are important advantages to trying to expand our definition of interdisciplinarity so that it contains some insight into how it is done. At present it is all too easy for scholars to claim that they are interdisciplinary. Whereas the main intellectual challenge to quality interdisciplinary research a couple of decades ago came from disciplinarians claiming that interdisciplinarity was inherently superficial (because of the years it takes to master even one discipline), the challenge today comes from disciplinarians who claim that anyone can be (or indeed is) interdisciplinary. Though it is common in the history of ideas for an idea to progress from being thought wrong to being thought obvious within a generation, such “progress” always carries the danger that the essence of the idea is forgotten along the way. Arguably, those that disdained interdisciplinarity decades ago had a better sense of what interdisciplinarians were trying to achieve than those who casually claim to be interdisciplinary today. Quality interdisciplinary work requires a serious engagement with each discipline one draws upon: This is far from impossible, but also far from being easy.

This article will suggest a number of best practices that might well come to be viewed as part of the definition of interdisciplinary research. But even at the outset we could suggest a couple of attitudes that might each be usefully included in our definition, and would encourage the sort of best practices to be outlined later:

- An openness to the theories, methods, types of data, and philosophical perspectives employed by any discipline (as well as to the things each discipline studies).
- An appreciation that each discipline is characterized by an overarching “disciplinary perspective” and that the insights derived from any discipline should be evaluated in the context of that perspective.

Acceptance even of these principles would go some way toward encouraging quality interdisciplinarity instead of superficial interdisciplinarity.

### *Synergy between Teaching and Research*

AIS was formed three decades ago with an emphasis on undergraduate education. In teaching about interdisciplinarity, we inevitably teach about interdisciplinary research: either actual or desired. Since we need to teach our students how to do interdisciplinary analysis, it is a natural evolution of AIS thinking to focus on how interdisciplinary research is best performed. This understanding informs how interdisciplinary teaching is best performed. The synergy between teaching and research also operates in the other direction: As the NSF and others have come to appreciate, those whose primary concern is interdisciplinary research must grapple with the question of how to educate future interdisciplinarians.

This synergy provides a common ground between those whose first interest is interdisciplinary teaching and those whose first interest is interdisciplinary research. It underpins our emerging connections with other organizations such as td-net (transdisciplinary-net), SciTS (Science of Team Science), and I2S (Integration and Implementation Sciences), each of which has a keen interest in identifying best practices in interdisciplinary research.

It is notable, if unsurprising, that the first texts on how to do interdisciplinary research—Augsburg, 2005, Repko, 2008, Repko, 2012—have emerged from AIS scholars. The best practices identified there and in Repko, Newell, and Szostak (2012) seem to be complementary to those identified within these other research communities. Notably, these texts are now used not just in undergraduate education but in graduate education and by interdisciplinary scholars.

### *Skepticism about Best Practices:*

Though scholars within and beyond AIS have had much success in identifying a complementary set of best practices (see below), there is skepticism in some circles about the very project of identifying best practices. It is useful to briefly address these objections (see Szostak, 2012):

- **That best practices are problem-specific.** This objection can only be answered empirically. Repko, Newell, and Szostak (2012) provide several case studies that apply the same set of best practices to quite diverse research questions. We should, of course, be careful to define the range of applicability of any best practice; some may

work better for some types of interdisciplinary research than others (the obvious case being strategies for team research that are of no use to the solo interdisciplinarian). But the experience of Repko, Newell, and Szostak (2012) suggests that it is indeed sensible to identify some best practices with wide applicability. Likewise, Bergmann et al. (2012) also describe various best practices that have been employed in various case studies in their volume, but argue that these each have much wider applicability.<sup>2</sup> Note that this battle is regularly fought within thematic interdisciplinary teaching programs. Many scholars in “X” studies programs think that the entire curriculum should be focused on “X” rather than on how common interdisciplinary strategies can be employed to better understand “X.” Scholars associated with AIS are likely to urge some education of students (and ideally their instructors) on interdisciplinarity itself.<sup>3</sup>

- **That we do not want to replicate within interdisciplinarity the weaknesses inherent in disciplinarity.** Most practicing interdisciplinarians are keenly aware of the limitations of disciplinary methodologies, and do not want to reduce the freedom inherent in interdisciplinarity. This objection can only be answered by showing that freedom can be maintained while pursuing best practices. And this in turn requires us to be clear on precisely what form of freedom we cherish. In particular, we need to appreciate that disciplinary methodologies constrain us in particular ways, limiting the things studied and the theories and methods employed. Interdisciplinary research should never be limited in these ways. If we can identify best practices that do not constrain research in these ways and indeed encourage and facilitate the exploration of the widest range of phenomena, theory, and method then we should be less concerned about disciplining interdisciplinarity.

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<sup>2</sup> Bammer (2013) also urges comparative case studies in order to identify what practices work where. She worries that much useful advice is spread across a diverse literature. She warns us to be wary also of unjustified generalizations.

<sup>3</sup> Lichtenstein (2012) discusses how and why scholars in gender studies have long proclaimed their interdisciplinarity while rarely interrogating the meaning of interdisciplinarity or appreciating that the history of gender studies parallels that of other interdisciplinary fields in important ways.

- **That interdisciplinary research is something one learns tacitly while doing it.** There is, of course, tacit knowledge that is hard to write down or communicate and is often unconscious or semiconscious in any activity. But the claim here is that interdisciplinarity is entirely tacit. This objection reflects the historical evolution of interdisciplinarity: Most practicing interdisciplinarians were trained in disciplines and have had to teach themselves how to do interdisciplinarity. But we need not burden the next generation with this task. Again, the objection can only be answered by identifying best practices and showing that these are useful in practice. This was the main goal of Repko, Newell, and Szostak (2012), and also Bergmann et al. (2012). Note that scholars used to feel the same way about university teaching, but that it is now accepted that it is useful to expose (especially young) scholars to strategies for effective teaching.
- **That interdisciplinary research is inherently intuitive.** We need to appreciate that all good research blends the rational and the intuitive, and that intuitive leaps come to the prepared mind. Indeed the subconscious mind is able to draw connections across disparate pieces of information that the conscious mind cannot see. But the subconscious can only draw connections if the appropriate information is gathered. And the subconscious throws up many ideas, not all of which survive reasoned analysis. The intent in identifying best practices is to provide the subconscious minds of interdisciplinarians with a better capacity to make novel and useful combinations. Welch (2007) has discussed these issues in some detail.
- **That we should not suggest that some interdisciplinary research is better than others.** But as noted above, the challenge to interdisciplinarity in today's academy is no longer primarily from disciplinarians who claim that it is impossible to do good interdisciplinary research, but rather from those who make the far more insidious claim that we are all interdisciplinary now and thus interdisciplinary programs are redundant (see Augsburg & Henry, 2010). Interdisciplinarity was once thought impossible and is now imagined to be easy. If we do not proclaim interdisciplinary best practices, we will be swamped by superficial interdisciplinarity.

I predict that these objections will be transcended as best practices are articulated and exposed to wider and wider audiences. (Others would, of course, disagree.)

## Identifying Best Practices

We need to organize our understanding of best practices. This, I believe, is best done in terms of a step-based research process, but necessarily with an appreciation that the steps are flexible and iterative. Researchers need not start at the first step, and will often find that they revisit earlier steps or perform multiple steps simultaneously. Nevertheless, the steps are logically distinct. And one critical strategy for evaluating interdisciplinary research is to ask whether all relevant steps have been performed appropriately. An appreciation of the best practices associated with each step will aid immeasurably in both the performance and evaluation of each step.

### *1. Forming a Research Team*

Given the focus within AIS on teaching students how to do research, we have paid little heed to this until recently. But *td-net* (which stresses links beyond the academy as well as across disciplines—see Hirsch Hadorn et al., 2008), *SciTS* (see Stokols et al., 2008), and others (such as the NSF-funded *Toolbox Project* at the University of Idaho—see O'Rourke et al., 2013) have been developing techniques for allowing scholars from different disciplines to understand each other and work together toward collectively articulated goals. This research, it should be noted, has implications for the classroom in two respects. First, interdisciplinarians often assign group projects to students. Second, students should be prepared for working in teams later in life. Several strands of research can be identified (see Stokols et al., 2008; Hall et al., 2011; Kessel et al., 2008):

- Identifying personality qualities of both team leaders and team members that are conducive to effective teamwork, and also the makeup of effective teams.
- Identifying strategies to ensure that team members interact effectively. One key insight here for AIS scholars is that some degree of “integration” is necessary at the start of a team research project, for team members need to understand what one another are trying

to do and say. Whereas the interdisciplinary research process outlined in Repko (2011) sees integration occurring late in the process, successful teams cannot wait until near the end to make sure that they are on the same page. To be sure, the actual integration of insights may still occur late in the process, but team members need early on to make sure they are speaking the same language and at least understand the perspectives that other team members bring.

- Developing common understandings of key concepts. If collaboration across only one or a few disciplinary boundaries is required, then researchers may successfully develop a new “pidgin” vocabulary that allows researchers in the team to understand each other (Galison, 1997). If wider communication is called for, the best strategy may involve breaking complex concepts into more basic concepts that lend themselves to shared understanding (Szostak, 2011; Szostak, 2013).
- Appreciating the strengths and weaknesses of each other’s theories and methods. This is something also stressed in the AIS literature. But team research may stumble at the very start if team members cannot transcend disciplinary preferences for particular theories and methods. (Szostak, 2004, identifies key strengths and weaknesses of different methods and types of theories.)
- Coming to grips with different epistemological, ethical, ideological, and other points of view. The Toolbox Project at the University of Idaho is identifying some of these points of view, and encourages research teams to discuss their differences (see O’Rourke et al., 2013).
- Identifying potential sources of disagreement that are best settled at the start (who will author reports and papers, take out patents, and so on).
- Overcoming institutional barriers. Resource allocation looms large here. But the team research community also worries a great deal about career progress. AIS members are well aware of the challenges that interdisciplinary scholars can face if hiring, tenure, promotion, and salary decisions are made by those in disciplines.

Team researchers face an additional challenge to the extent that team research requires a heavy investment of time at the outset with little in the way of publications to show for a while.

- Various other issues, among which special attention might be paid to time management and data management. Team research can be very time-consuming, and team members will fall away unless they see that the time they put in is leading to results. Teams cannot build on each other's work without good protocols for sharing data of all sorts.<sup>4</sup>

## *2. Identifying a Good Research Question*

We have identified several criteria for a good question: It should be clear, precise, manageable, researchable, jargon-free, important, and address complex issues that no single discipline can deal with. In particular we have noted the danger of framing a question in a way that privileges some disciplines over others (see Repko, 2011).

- In team research, the question is generally best developed collectively (especially when the team includes non-academics). It is shared commitment to guiding research questions that holds the group together.

## *3. Identifying and Evaluating Relevant Insights from Relevant Disciplines*

This has been a key focus of AIS scholars. Multiple chapters in Repko (2011) are devoted to identifying disciplines, theories, and methods, and performing literature searches. There are two complementary approaches to identifying relevant disciplines:

- Researchers can identify relevant disciplines through recourse to disciplinary perspective.
- Or they can first identify relevant phenomena, theories, and methods, and then ask which disciplines study/employ these. It is thus useful for the interdisciplinarian to have access to comprehensive

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<sup>4</sup> The special challenges of collaboration at a distance are addressed in Olson et al. (2008).

lists of the phenomena scholars study, and the methods, theories, and types of data employed. It is further useful to have access to an analysis of some of the key strengths and weaknesses of different theory types, methods, and types of data. These are provided in Szostak (2004) and reprised with thumbnail sketches of key disciplines in Repko (2011).

Undergraduate student researchers will generally wish to limit themselves to disciplines that have actively researched (some aspect of) the research question. More advanced researchers may find it valuable to reflect upon or perform the research that a discipline has not yet undertaken.

Our colleagues in td-net (see Despres et al., 2008) stress that for research with policy implications the sorts of “scientific” understandings emphasized above need to be supplemented by

- “practical” knowledge about what is possible,
- “ethical” knowledge about desirable goals, and
- “aesthetic” knowledge of what is beautiful (for some projects).

Interdisciplinary researchers face much greater difficulties searching the existing literature than disciplinary researchers. First, the scope of the literature search is generally greater because of the interest in complex problems. Second, library and online catalogs are organized around disciplines, and thus interdisciplinary researchers will need to master the terminology employed within each relevant discipline if they are not to miss important works.<sup>5</sup> Perhaps the best advice to give the interdisciplinary researcher is that no search strategy is perfect. The use of multiple strategies is thus recommended:

- Subject searching is highly recommended, but requires the researcher to identify appropriate subject headings. These may differ by discipline. Since books are usually only identified in terms of a handful of subjects at most, subject searching will not identify all relevant works.
- Keyword searching is easier, but there is a greater risk that impor-

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<sup>5</sup> A more interdisciplinarity-friendly system of document classification is possible; see Szostak (2011).

tant works will be missed simply because different terminology is employed in different disciplines.

- The above strategies work best for books. For articles, there are various online databases that can be searched. Some are general, others specific to disciplines. Most university libraries will provide an overview of the databases that can be searched.
- Full text searching is increasingly possible. The advantage is that one can find works that address one's topic in the text but not at such length that the topic is reflected in title, abstract, or subject headings. While some view full text searching as a panacea for the challenges of interdisciplinary literature searches, the problem of different terminology in different disciplines still remains.
- Consulting experts in disciplines not represented in the research team is time-consuming but can not only identify works that other strategies might miss but also aid in placing these in context.
- Consulting experts outside the academy will be crucial if the research process is to embrace non-academic insights, for these are often difficult or impossible to identify through library search strategies.
- Browsing the shelves near works that have been identified by other strategies will often uncover new works that are relevant.
- Following citation trails (backward through the work's list of references, or forward by consulting citation indices) can also be valuable. In doing so we have access to the results of other scholars' search strategies. But important works may have been missed by others.

When the interdisciplinarian proceeds to reading works, it is important not just to keep track of the insights generated by a work but also of its disciplinary perspective, theories and methods employed, data utilized, concepts employed, and phenomena and relationships studied. This will facilitate evaluation of these insights. The researcher will find that some authors are less clear than they should be about some of these elements.

Disciplinarians have long wondered about the ability of interdisciplin-

ary scholars to fully understand the disciplinary literatures that they draw upon. And, of course, the interdisciplinarian cannot be expected to have the same depth of understanding as the specialized disciplinary scholar. Perhaps the key insight of interdisciplinary scholarship is that this depth of expertise is not essential. The interdisciplinarian need not master an entire discipline but rather only understand the insights that it generates regarding the research question, and place these insights within the context of that discipline's overall perspective. In evaluating the discipline's insights, the interdisciplinarian has several *advantages* over the disciplinary researcher:

- The interdisciplinarian can compare and contrast insights generated by different disciplines. The interdisciplinarian can then ask why these insights are in conflict. (Note that doing so is critical for the later step of integration.)
- The interdisciplinarian can ask to what extent the discipline's insights reflect its disciplinary perspective. The disciplinarian that is not self-conscious about disciplinary perspective cannot ask such a question.
- While the disciplinarian may have more detailed knowledge of a particular theory or method, the interdisciplinarian can bring an understanding of the relative strengths and weaknesses of different theories and methods (see above). This may allow identification of problems missed by the disciplinarian (because each discipline tends to downplay the limitations of favored theories and methods). It also facilitates the identification of alternative theories and methods that might generate different conclusions.
- The interdisciplinarian by mapping a complex system can place any disciplinary insight in context. All too often, disciplinary researchers will examine a particular relationship (how B influences C) in detail, but then (often implicitly) assume that other relationships (A influencing B or C influencing D) operate in a particular way and then reach a conclusion about a much more complex chain of relationships (how A influences D through B and C) than they have actually studied. The interdisciplinarian may be able to draw on other disciplines that actually study these other relationships.
- More generally, the interdisciplinarian can ask whether the dis-

disciplinary analysis has ignored critical variables studied by other disciplines (or perhaps ignored by all), and analyze how the discipline's conclusions would change if these were included.

- Once the potential sources of bias in disciplinary insights have been identified, the interdisciplinarian can triangulate across different theories and methods to achieve a more accurate understanding than any one discipline can achieve.
- Since interdisciplinarians are expected to be explicit about the search for bias, they should also be more diligent in assuring that particular insights are not favored simply because they accord with their personal biases.

Two points should be stressed:

- Interdisciplinarians risk being superficial if they take insights from a particular work without placing these in context or evaluating them. Such practices are worthy of disdain, and assessment of interdisciplinary work needs to ensure that the interdisciplinarian has placed insights in context and evaluated them. Note that evaluation is an important task for all insights, not just those found to be in conflict.
- The non-superficial interdisciplinarian brings valuable skills and strategies to the task of evaluating disciplinary insights. These are *complementary* to the forms of evaluation pursued by the disciplinarian, which will stress detailed examination of the theory employed, techniques applied, and data analyzed. (Of course, the interdisciplinarian may do this sort of evaluation, too.)

#### *4. Mapping the Relationships among the Phenomena Being Studied*

Though it is widely appreciated that interdisciplinarity is called for when researchers are faced with a complex problem (there is less consensus on how to define “complex” in this context—see the debate in the 2001 and 2002 volumes of *Issues in Integrative Studies*), it is not always appreciated that the interdisciplinarian needs thus to come to understand a system of interactions. Usually, different disciplines focus on different relationships

within this system. Often, disciplines talk past each other by being unaware that they are talking about different relationships. Interdisciplinary researchers will have trouble connecting disciplinary insights and understanding why these might differ if they do not visualize the full set of relationships relevant to a particular research question. Repko (2011) devotes considerable attention to the value of mapping the relationships among variables emphasized by different disciplines (so that we know when they are talking about the same or different things, and can see which variables are ignored by some disciplines). Notably, Repko guides researchers to consider the full range of relevant phenomena, theories, and methods. Two of the strategies for “theoretical framing” identified in Bergmann et al. (2012) involve mapping. The same is true of two of their three strategies for integrating methods. They later stress the critical importance of some sort of model to transdisciplinary research. Keestra (2012) provides a detailed analysis of one particular mapping strategy. Mathews and Jones (2008) outline a more general mapping strategy useful for both teaching and research.

If the goal of the research is to suggest ways that the results emanating from the system might be changed, then the mapping exercise may also serve to identify the best place(s) in the system to intervene in order to effect change. It is notable in this respect that many policy theorists now hypothesize that achieving desired change in complex systems may require multiple interventions that work together toward desired changes but counteract negative side effects.<sup>6</sup>

### *5. Performing Multiple Methods Research*

Again, this has not been a central focus of AIS scholarship to date. But this is changing as our focus expands into graduate education and research more generally. Fortunately there are a host of texts out there that focus on multiple methods research. We need to ensure that the best practices identified in this literature are compatible with the best practices identified by interdisciplinary researchers. In particular, we need to ensure that this literature does not (perhaps inadvertently) encourage interdisciplinary researchers to privilege some methods (or perhaps theories or types of data) over others.

It is critical yet again to appreciate that all methods have strengths and weaknesses, and thus to strive to combine methods with compensat-

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<sup>6</sup> In some cases, mapping may set the stage for more formal modeling. Badham (2010) provides a useful survey of both formal modeling techniques and techniques for what has been termed mapping here.

ing strengths. We must recall that all methods are biased, and thus no one method should be relied upon exclusively. An appreciation of the strengths and weaknesses of different methods should guide not only the selection of methods but analysis of the results obtained, especially if different methods generate different results.

The core precept of multiple methods research is that each method is to be employed properly. Researchers should be familiar with best practices for each method employed, and potential problems.

The literature on multiple methods research (MMR) stresses the mixing of quantitative and qualitative methods (Johnson et al., 2007). Szostak (forthcoming) urges a greater appreciation of the differences among particular methods in each of these categories. The MMR literature also appreciates that methods are embedded in broader “paradigms” and thus mixing methods requires mixing of the epistemological and metaphysical premises that support particular methods. Szostak (forthcoming) recommends an enhanced appreciation of all of the elements of disciplinary perspective, but especially theory and phenomena studied.

MMR is primarily justified in terms of triangulation: It is hoped that using different methods can increase our confidence in certain empirical results. The literature on interdisciplinarity has often spoken of triangulation. But we have spent much more of our time worrying about how to integrate (the insights embedded in) theories than methods. Yet integrating methods is not just of critical interest in MMR but also in the literatures of transdisciplinarity and team science.

Triangulation is the dominant but not sole justification for MMR. Often different methods are employed to study different aspects of a complex problem. This type of MMR is facilitated by both mapping and an appreciation of the strengths and weaknesses of different methods. A third type of MMR employs methods sequentially, as when interviews are performed with members of groups identified statistically. This sort of MMR depends on asking a very clear research question and appreciating which facets of that are amenable to which methods.

## *6. Integrating Insights from Different Disciplines*

We have identified four key techniques for creating common ground:

- Redefinition involves altering the way a concept is employed by different authors in order to achieve a common meaning. This tech-

nique is powerful when authors appear to be disagreeing because they are using the same concept in different ways. When one redefines a concept, and then restates the authors' insights in terms of the redefined concept, the apparent conflict vanishes. In other cases redefinition resolves only some of the conflict between insights but by clarifying the nature of this conflict sets the stage for the use of other techniques. The redefined concept or concepts are the common ground.

- Extension involves extending a theory, or the assumptions underlying a theory, so that it includes elements identified by other authors. This technique works best when different insights are potentially complementary. Different authors emphasize different causal factors, but there is no reason why these cannot work in concert. If one is extending a theory it is generally best to extend the theory that is already the most comprehensive. If no theory is very comprehensive, then the interdisciplinary researcher can usefully explore whether there is some common set of assumptions that might allow theories to be combined. The extended theory or assumption is the common ground.
- Organization involves using a map to show how different insights are related. If one author stresses cultural influences on a particular behavior and another stresses personal influences, organization might involve showing how culture influences personal decisions that affect behavior. The map becomes the common ground. Note that it will often prove useful to group the phenomena emphasized by different authors into broader categories (such as cultural attitudes).
- Transformation is a technique for addressing opposites by placing these on a continuum. If one author assumes that agents behave rationally in a particular situation, but another author assumes irrationality, the interdisciplinary can appreciate that there is a continuum between perfect rationality and perfect irrationality, identify where on that continuum agents are likely to lie in a particular situation, and then draw on each of the opposing insights appropriately. The continuum is the common ground.

These techniques work when authors disagree (or appear to disagree) about how the world works. Such disagreements may or may not be embod-

ied in formal theories or concepts. If disagreements are instead grounded in different empirical understandings, then triangulating across different methods and types of data as suggested in the previous step is the best strategy. If the source of conflict can be traced instead to values, the four techniques outlined here are again useful:

- **Redefinition.** Ethical terms are often very emotive. Clarifying how authors are using terms such as “freedom” or “justice” may yield common ground.
- **Extension.** Interdisciplinary can seek policies that appeal to the widest range of rules, virtues, and traditions.
- **Organization.** If a virtue approach<sup>7</sup> disdains a particular policy because of concerns over process, but a consequentialist approach applauds the results, the interdisciplinary can investigate whether a different process can achieve similar results.
- **Transformation.** Conflicting rights can be placed on a continuum: freedom to act versus freedom not to be hurt by others. The same can be done with other rules or also virtues that conflict. (The Aristotelian Golden Mean suggests that the best path will generally fall between extremes.)

### *7. Reflect, Test, and Communicate*

Repko’s (2011) final chapter addresses each of these sub-steps briefly.

There are at least three important forms of reflection:

- Reflect on what has been learned, both about the research question in particular and about the interdisciplinary research process in general.
- Reflect on which steps in the research process have not been treated

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<sup>7</sup> Szostak (2005) discusses the five ways that humans make ethical decisions. A virtue approach evaluates acts in terms of whether they are courageous or honest or dutiful (or accord with countless other virtues). Consequentialists evaluate an act in terms of whether it has good consequences. Deontologists stress following rules (such as rights, or the Golden Rule or the Kantian Categorical Imperative). The other two types are intuition and tradition.

as carefully as they could have been.

- Reflect on one's own biases.

The last sort of reflection in particular should be performed throughout the research process. Since bias is largely subconscious, this sort of reflection is best guided by a conscious awareness of possible sources of bias:

- Humans have limited perceptual and cognitive capabilities.
- Researchers cannot entirely escape cultural biases or political pressures to "find" particular results.
- Scholars operate within institutional structures that encourage certain sorts of behavior and discourage others.
- Scholars likewise operate within scholarly perspectives inherited from the past.

Repko (2011, pp. 418-425) lists and integrates four tests of the interdisciplinary understanding:

- Ask whether the results are useful. Do they solve the problem, answer the question? Do they support effective action?
- Do others find the research useful and interesting?
- Do we gain insight that is superior to what existed before? Is the interdisciplinary understanding better in some way than disciplinary understandings?
- Is the research program clear and were all steps performed well? In particular, are disciplinary insights appropriately represented in the interdisciplinary understanding?

Note that the first three are holistic tests. The latter instead suggests a number of more precise questions. Both types of test are important. The proposed tests are complements.

Researchers will generally wish to reach multiple audiences. They will need to:

- Use language appropriate to each audience.
- Relate their research outcomes to the concerns of each audience.
- Be both clear and memorable. The latter generally requires recourse to metaphor, model, or narrative. Elucidation of a new policy, product, and/or research question is also useful. Providing real-world examples of at least the problem and ideally the solution can be very powerful. Emphasize the surprising elements of one's research.
- Note that communicating to the public may be important in encouraging policymakers to act.

More research is needed on the key question of how interdisciplinary scholarship can usefully inform public policy. It is commonplace to observe that interdisciplinarity is necessitated by complex problems that span disciplinary boundaries. But several challenges exist in translating insights into policies that work. Fortunately, each of these can be addressed by interdisciplinary scholarship:

- How can we achieve broad agreement, first of all, on the goals of public policy? Interdisciplinary scholars need to explore how apparent contradictions in public attitudes can be transcended. Integrative techniques can be applied here, but the interdisciplinary scholar will need to confront questions of ethics/values head on (see Szostak, 2005), and also appreciate that people's attitudes depend importantly on how an issue is framed. (We should also encourage wider appreciation of the critical importance of open-mindedness.)
- How can the public gain confidence in interdisciplinary insights? The limited success that some public policies seem to have achieved (perhaps due to exaggerated expectations) has reduced public confidence that there are "expert" solutions to pressing problems. We need to argue that interdisciplinary analysis can generate better policies. And this will require in turn being forceful regarding the existence of interdisciplinary best practices.
- How can we ensure that policies do not have negative side-effects that cause them to do more harm than good? Here, the sort of mapping exercise recommended above becomes absolutely critical. We need to trace not just the effects on the phenomena that we want to

affect but also the effects on those that we do not wish to affect.

And how can interdisciplinarians best communicate ideas beyond the academy? Interdisciplinarians have a head start in that we often eschew needless jargon. But the lessons we master in trying to address different disciplinary audiences—in particular framing our ideas in terms of their ongoing conversation—need to be applied in the public arena. And perhaps critically we need a two-way conversation (as our transdisciplinary colleagues have shown) for the public has much to tell us about how the world works. After all, one key insight of interdisciplinary scholarship is that interdisciplinary research is an ongoing process, and that our understanding improves as we integrate across a wider and wider set of insights generated from different perspectives. It should be stressed that the best way to communicate policy ideas to stakeholders and policymakers is to involve them in a two-way conversation from the start.

### *8. Assessing Interdisciplinary Research*

Quite simply, interdisciplinary research projects cannot be evaluated fairly against the standards of any one discipline. This is one major advantage of developing a shared understanding of the interdisciplinary research process within the community of interdisciplinarians.

In the absence of clear standards for interdisciplinary assessment, two dangers may arise:

- No objective standards are employed, with the result that superficial interdisciplinary analysis gains undeserved prominence.
- Disciplinary standards are imposed, with the result that only superficially interdisciplinary research is favored.

Our understanding of the interdisciplinary research process suggests that research should be evaluated in terms of certain questions:

- Is the guiding question important?
- Is an interdisciplinary approach justified?
- Were relevant steps performed?
- Were relevant strategies employed?
- Were relevant disciplines consulted, and relevant theories and

methods engaged?

- Were theories and methods described and employed accurately?
- Were results expressed in an appropriate manner for intended audiences?
- Was clear terminology employed and any jargon both necessary and carefully defined?
- Was the research reflective?

Lyall et al. (2011) provide detailed advice for journal editors, referees, and grant adjudicators on how to evaluate interdisciplinary research in terms of these sorts of standards. That book also addresses how universities should evaluate the career progress of interdisciplinary scholars.

## Concluding Remarks

This brief article has sought only to provide an overview of the state of the field and point readers to some of the relevant literature. The AIS hopes over time to put more detailed information regarding such matters as definitions and best practices (for teaching and administration as well as research) on its website. But the take-away message is twofold: that we have achieved a great deal of consensus not only about what interdisciplinarity is but also how it is best performed; and that these insights are being expanded and refined by an international and interdisciplinary collection of scholars.

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