

ISSUES IN INTEGRATIVE STUDIES
No. 20, pp. 103-122 (2002)

How to Do Interdisciplinarity: Integrating the Debate

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Abstract: This paper develops a twelve-step process for interdisciplinary research. While individual researchers cannot be expected to follow all of these steps in every research project, the process alerts them to the dangers of omitting steps. Moreover, communities of interdisciplinary researchers should ensure that all steps are followed. The process draws upon earlier efforts by William (Bill) Newell and Julie Thompson Klein. It also draws inductively upon the debate concerning Newell's theory of interdisciplinarity in the last issue of this journal; all of the concerns raised during that debate find a place in this process. Finally, the paper illustrates how several classifications developed by the author facilitate interdisciplinary research.

IN THE 2001 NUMBER of *Issues in Integrative Studies*, William Newell (2001) put forward a novel theory of interdisciplinarity. This was critiqued by Stanley Bailis (2001), Julie Thompson Klein (2001), J. Linn Mackey (2001), Richard Carp (2001), and Jack Meek (2001). Newell suggested that his theory supported a certain multiple-step approach to performing interdisciplinary research. The respondents evinced varying degrees of discomfort with the suggested process. In particular, Bailis (2001) wondered why the steps were not defined concretely—as much as possible—in terms of, say, methods or theories, rather than in terms of harder to operationalize variables such as disciplinary perspectives (pp. 35–36). Carp worried that the Newell process was unintentionally exclusionary of many valuable interdisciplinary pursuits.

This debate is rich and varied, and the literature on interdisciplinarity would be well-served by its continuation. My article hopes to pinpoint several key areas of disagreement and discuss how these might become the subject of empirical investigation. Some organizing structure is thus desirable, so that the connections among all of these areas of disagreement can readily

be appreciated. The article is structured around a multiple-step guide to the performance of interdisciplinary research that is at once both more concrete and more inclusive than the set of “steps” proffered by Newell. These dual goals can be achieved in part by the provision of greater detail than Newell had. While these various steps will be outlined at an “eminently describable level” (Bailis 2001, p. 36), they nevertheless provide scope for the exercise of the multiple visions of interdisciplinarity expressed during that debate. It is thus hoped that (much of) the debate could come to be focused on the relative importance of, and most desirable way to use, various steps within a generally accepted framework.

This multiple-step process was developed inductively by first reading the various articles and identifying their implications for the practice of interdisciplinarity, and then identifying a set of steps that would subsume all of these. Scholarship benefits generally from a mixture of induction and deduction; this enterprise benefited in the latter respect from the previous efforts of both Newell and Klein to outline processes for the performance of interdisciplinary analysis. The result is ideally broad enough to embrace any particular vision of an interdisciplinary process. The hope is that, while some scholars might judge some steps or substeps unimportant or unnecessary, they could not identify necessary steps that are missing from this process. The process can thus provide guidance on how interdisciplinary research should proceed, without excluding any valid form of interdisciplinary research.¹ What, though, qualifies as valid interdisciplinary research? The utility of the process depends on the steps being specified precisely, so that they clearly distinguish, where appropriate, interdisciplinary from disciplinary research (we should at least be open to the possibility that some aspects of interdisciplinary research look a lot like disciplinary research). This article will attempt to identify each step precisely: *The explanatory material is thus an essential component of the steps, as much as the step’s title statement.* Further research could profitably identify further essential characteristics of interdisciplinary research.

My own recent research, including articles in the last two issues of this journal, has developed classifications of the phenomena studied by scholars, scholarly theories, methods, ethical perspectives, and critiques of scholarly practice. The debate between Newell and his critics clarifies how these classifications might be useful to interdisciplinarians. I will discuss below how various steps in interdisciplinary analysis could benefit from recourse to one or more of these classifications. Note that the value of these classifications can only be appreciated once at least some of these steps are outlined.

As I argue in the May 2003 *AIS Newsletter* (2003e), we should strive as teachers to inform our students of what interdisciplinarity is and how it is performed. While this article is focused upon interdisciplinary research, I hope that it will also be of use in interdisciplinary teaching.

How to Do Interdisciplinarity

Isaac Newton famously said that he was able to achieve much only because he stood on the shoulders of giants. The following framework borrows heavily from the previous efforts of both Bill Newell and Julie Thompson Klein, as well as the various comments made during the debate. As Klein and Carp both noted, and Newell concurred in his response, we must be careful to recognize the existence of feedback; while performing a later step in the interdisciplinary process we may see advantages in revisiting some of the earlier steps. Some overlap between steps is thus not problematic, and may even be desirable. Moreover, the process in its entirety should be seen as a guideline for the community of scholars as a whole. The individual researcher, and many teams of researchers, will generally only be able to perform some subset of these steps in any detail. Such researchers will still benefit from acquaintance with a list of suggested steps; teams in particular should find the list helpful in assigning tasks to team members. Researchers should be warned of the costs of eschewing particular steps.² If researchers are explicit about the steps omitted, it is more likely that other researchers can and will fill in the gaps. As Mackey (2001) emphasized, our goal must be an ongoing conversation among scholars in which we build on each other's work (p. 64). The following discussion is also intended to provide guidance on how to perform each step.

1. Start with an interdisciplinary question. In some cases, researchers may start instead with a topic or issue in mind. An early goal of a research project, nevertheless, should be the identification of a question or questions that can guide research. Feedback to this step is common. What sorts of questions, though, are suitably interdisciplinary? Newell suggested that only questions about complex systems, as defined by complexity theory, are suitably interdisciplinary; if the process being investigated is not complex, then different disciplinary insights can potentially be added together through multidisciplinary analysis. Other commentators worried that the Newell definition was too narrow. They wished to embrace any question that drew on insights from more than one discipline. Note, in either case, that a researcher might not know at the moment that s/he formulates a research question whether

it will require interdisciplinarity.

2. *Identify the key phenomena involved, but also subsidiary phenomena.* “Phenomena” is used here in the precise sense outlined in my own recent articles (2000, 2001) in this journal, to refer to the subject matter addressed by scholars. The interdisciplinary literature in general, and this debate in particular, is silent on how interdisciplinary researchers would go about identifying key and subsidiary phenomena. Scholars may gain an enhanced appreciation of the phenomena involved during the literature review stage (below). In order not to be seduced by the existing literature, and thus continue to ignore relevant phenomena just because other scholars have, it is advisable for the interdisciplinary researcher to reflect on this question independently. But how? Exposure to a list of all of the possibilities (such as the schema outlined in Szostak, 2000 and 2003, and a similar list of natural science phenomena) would be invaluable here. Scholars could then ask whether “social structure” or “attitudes toward honesty” or “climate” are important for the question at hand; they might well find in such an exercise that phenomena ignored by others had clear relevance. Indeed, one of the conclusions reached in Szostak (2003) was that there is some causal relationship between virtually every pair of phenomena.

Carp (2001) encourages us to appreciate that our understanding of any issue is necessarily imperfect, and thus applying our understanding to the real world often yields unforeseen consequences (p. 74). The best—though still imperfect—antidote to unforeseen consequences is to contemplate likely effects over as wide a range of phenomena as possible. A comprehensive list of phenomena should thus aid scholarly understanding and public policy advice.

3. *Ascertain what theories and methods are particularly relevant to the question at hand. As with phenomena, be careful not to casually ignore theories and methods that may shed some lesser light on the question.* Does interdisciplinary research require the use of theories or methods or both from multiple disciplines? Szostak (in press, c) defined interdisciplinarity in terms, primarily, of an openness to the theories, methods, and/or phenomena embraced by multiple disciplines. Others might wish to insist on integration of all three types—and also of an interdisciplinary worldview (see below). We might wish to identify different degrees of interdisciplinarity, depending on how many of these different types of integration are undertaken. In practice, there are complementarities such that borrowing a theory from one discipline will encourage use of its methods, study of its phenomena, and engagement with its worldview. Meek (2001) worried that the identification of “rel-

evant disciplines and concepts,” as recommended by Newell, was highly context dependent (p.131). That is, researchers facing a new question would have no clear guidance on where to look. Szostak (2003a) develops a typology of theory types, and shows where several key theories fit in the typology. It should be noted here that different theories are suited to different phenomena: for example, some theories describe group processes, others focus upon individual actions, and others emphasize relationships. Researchers thus need guidance as to what sorts of theories to draw upon in particular situations. The sorts of questions that interdisciplinarians investigate—especially within Newell’s definition of interdisciplinarity—are likely to involve different types of agent, action, decision-making process, and timepath. The typology will thus guide interdisciplinarians to draw upon multiple theories. The very insight that scholars should generally seek a complex amalgam of theories, rather than one grand theory, is itself invaluable.

Szostak (2003b) identifies a dozen scientific methods, and their key strengths and weaknesses. As with theories, scholars thus have advice as to which method is best suited to certain tasks, and reason to suspect that interdisciplinary investigations will benefit from multiple methods. Note that particular methods are best at investigating the types of agents, actions, decision-making processes, and timepaths emphasized by particular theories; reliance on one method thus tends to bias results toward a particular theory.

Disciplinary scholars are sometimes constrained by the availability of one or two methods or theories that dominate their field. One key attribute of interdisciplinarity is an openness to any suitable theory or method. Interdisciplinarians cannot take advantage of this freedom fully unless readily acquainted with the strengths and weaknesses of all possible methods and types of theory.

4. *Perform a detailed literature survey.* Literature reviews are generally an early step in research. Given the many concerns voiced during the debate about the research on which interdisciplinary research must build, it seems advisable to encourage some reflection on relevant theories, methods, and phenomena before engaging in a detailed survey of the literature. As already noted, the literature search will likely raise additional concerns. The goal is primarily to identify the theories, methods, and phenomena encompassed by previous research, and also the results of that research. It is important here to recognize that different disciplines may use different terminology to describe the same phenomenon, process, or even theory. It is therefore critical that the relevant disciplines be identified and their terminology investigated. That is, if interested in a particular phenomenon, one cannot sim-

ply search by the phenomenon name but should reflect on which disciplines might study the phenomenon and investigate whether it goes by a different name in that discipline; otherwise one's literature survey may be seriously deficient. Carp (2001), in particular, emphasized that the non-scholarly literature may also have important contributions to make (p. 84). Note that theories and methods may be less explicit in this literature.

The responsibility of performing an extensive literature review is greater for interdisciplinarians than for disciplinarians, who may need to master only a small, specialized literature (though disciplinary researchers can benefit from broadening their gaze). Present methods of document classification in libraries serve the interdisciplinary researcher poorly; Szostak (2003b; in press, d) discusses how classifications grounded, not in disciplines, but in universal lists of phenomena, theory types, methods, and so on could allow researchers of all types, but especially interdisciplinarians, to identify relevant research from diverse disciplines (and beyond) for any topic. In particular, works at present are rarely classified with respect to the theory and method employed; it is thus very difficult to identify works in various disciplines that may have employed the same theory or method.

5. *Identify relevant disciplines and disciplinary perspectives.* We have already seen that a proper literature survey requires identification of relevant disciplines because of the disciplinary basis of library catalogues. The fact that the bulk of academic research occurs within disciplines implies that disciplines need to be engaged on a wider front. Identification of relevant disciplines, and then of their favored theories, methods, and subject matter, may help in steps 2 and 3, though at the risk of omitting that which no discipline covers (and Newell stressed that one important task of interdisciplinary research should be to fill in any "gaps" between disciplines [2001]). The particular "worldview" or perspective of a discipline will also shape how theories and methods are applied, and results interpreted, and should thus inform the interdisciplinarian's reading of the literature. Note that disciplinary perspectives are self-reinforcing; the theory will be applied in a manner congenial to the method(s) and phenomena embraced by the discipline; overall philosophical and ideological outlooks will both influence and reflect the theories, methods, and phenomena.

Carp (2001) criticized Newell for privileging disciplines. One can be an interdisciplinarian, he argued, without believing that disciplines are as logical or coherent as Newell suggested (p. 83). In turn, Klein and Carp both noted that disciplines were constantly evolving. The process outlined here is agnostic on the question of the nature of disciplines; it simply notes that in

both the performance of literature reviews and the evaluation of research, disciplinary perspectives can be implicated. In neither case does this require a belief that disciplines are good or bad, but merely an appreciation that they shape the scholarly literature.

However, the question of how logical and coherent disciplines are is subject to empirical investigation, and interdisciplinarians may be in a good position to do that. Disciplines can be identified at any point in time in terms of a bundle of phenomena studied and theories and methods applied. If interdisciplinarians find that the phenomena embraced by a particular discipline, and the causal links among these, are best studied by that discipline's theories and methods, a case for disciplinary coherence can be made. If, instead, interdisciplinarians find that theories and methods from outside that discipline do as good or a better job of illuminating these phenomena/links, or find that these "external" theories and methods illuminate some aspects of these phenomena/links ignored by the discipline's theories and methods, then a case could be made for incoherence. A discovery that the causal links between a discipline's phenomena and phenomena studied by other disciplines (or ignored by all) were not only important, but affected the links among the discipline's phenomena in ways that the discipline's theories failed to recognize, would also be indicative of incoherence. That is, a finding that economic relationships were influenced importantly by culture would signal that the discipline of economics places serious limits on our collective understanding, as would a finding that the theories and methods of, say, sociology provide valuable insight into economic relationships. Obviously, community judgment would have to be exercised in determining whether the costs of a particular discipline—in terms of ignoring relevant theories, methods, or phenomena—outweighed the benefits that flow from a community of scholars with a shared expertise. The very premise of interdisciplinarity is that disciplines cannot explain everything, and thus the first sign of disciplinary narrowness cannot be taken as proof of incoherence. Empirical evaluation of the logic and coherence of different disciplines is nevertheless both possible and desirable.

Since disciplines evolve, terminology changes, and disciplinary perspectives are hard to pin down, steps involving disciplinary perspectives are among the most difficult in the entire process. Recall that Bailis (2001) wished to avoid as much as possible the definition of steps in terms of vague terminology such as "disciplinary perspective" (pp. 35–36). Newell (2001) seems to implicitly recognize this point when he argues that researchers need not master every relevant discipline, but simply gain a "feel" for the disci-

plinary perspective and master the relevant theories and methods (pp. 14–15). He would worry, I believe, that the step of evaluating disciplinary perspectives might be eschewed simply because it is less obvious how to proceed.

The community of interdisciplinarians could do a better job of operationalizing the concept of “disciplinary perspective.” Szostak (in press, c) suggested that a key step—in addition to a discipline’s favored theory, method, and phenomena—would be “philosophical orientation,” and outlined a set of five broad approaches to philosophical analysis,³ admitting that there are other steps likely to be considered. Carp stresses in his article the ideological underpinnings of modern disciplinary structures. The community of interdisciplinarians could also do much to identify the various disciplinary perspectives *at a point in time* in terms of the constituent theories, methods, phenomena, and ethical perspectives. Finally, interdisciplinarians could strive to translate disciplinary terminology into more common usage. One of the purposes of the classifications of phenomena, theory, and method discussed above is to provide the basis for a common semantic understanding, at least among interdisciplinarians.

Here and elsewhere, we see the interdisciplinarian struggling to benefit from specialized research while overcoming its costs. Much of the debate was focused at the level of disciplines. If, instead, framed in terms of “specialization,” few would doubt that research focused on a narrow question and undertaken by a researcher expert in a particular theory and method, can be quite valuable. The interdisciplinarian researcher may find it more useful to focus at the level of subdisciplinary fields than entire disciplines in identifying relevant theories, methods, and phenomena (Dogan & Pahre 1990). If so, the questions raised above about the logic and coherence of disciplines could usefully be engaged at the level of subdisciplines. The goal should be to identify, and then strive for, the ideal institutional balance between specialization and integration. The question of whether “perspectives” are best understood at the level of disciplines or subdisciplines has hardly been addressed. If, though, it is during graduate school that perspectives are first absorbed by future academics, then the discipline will likely remain an important focus of analysis. Like many other questions raised in this article, the relative importance of disciplines versus subdisciplines to interdisciplinarian research could be subjected to much greater empirical analysis.

Interdisciplinarity has been successful enough that much research is now undertaken within interdisciplinarian fields. These must, of course, be included in any step that identifies relevant disciplines. Do interdisciplinarian

fields inevitably become disciplines, as Stanley Fish famously suggested? An investigation and comparison of the nature of disciplinary perspectives, as well as the perspectives of interdisciplinary fields, would be particularly useful in this regard.

6. *If some relevant phenomena (or links among these), theories, or methods identified in (2) and (3) have received little or no attention in the literature, the researcher should try to perform or encourage the performance of such research.* Newell (2001) stresses that studying links ignored by disciplines is one of the key tasks of interdisciplinarians (p. 18). None of the respondents disagree. The process here extends to the realm of theory and method as well. This extension flows from the common observation that disciplinary perspectives are characterized not only by a particular subject matter but also by favored theories and methods. In the case of theory, the interdisciplinarian will often be called upon to develop new theories, or at least new versions of theories.

How should this step be undertaken? It may be possible, in the first instance, for the interdisciplinarian to speculate on the likely results of such research. Moreover, the non-scholarly literature, being less constrained by disciplinary perspectives, may have filled some of the gaps in the scholarly literature. If new research is performed, this may bear a strong similarity to disciplinary research, except that the interdisciplinarian would be open to a wider range of theories, methods, and phenomena, than a single discipline would countenance. For Newell (2001), though, there would be an important difference; he posited that the relationships investigated by interdisciplinarians will be non-linear (p.8); we return to this issue below.

7. *Evaluate the results of previous research.* This must often involve some degree of mastery of the theories, methods, and perhaps phenomena implicated in that research. Any disagreement here is more apparent than real. While Newell feels that there is a natural logic to disciplines, he strongly encouraged the careful analysis of the results of disciplinary research. The same injunction would apply to research emanating from subdisciplines or interdisciplinary fields. The process outlined here suggests several ways in which interdisciplinary analysis can make a particular contribution to this task. At one point, though, Newell (2001a) suggested that if cross-disciplinary links were linear we could simply perform multidisciplinary analysis rather than interdisciplinary (p.144). We should be careful not to suggest that evaluation is not a suitably interdisciplinary endeavor.

The role of the interdisciplinarian is to place the results of specialized research in a broader context; this need not and should not mean that the

results of specialized research are taken without question. Indeed, one of the key insights of interdisciplinarity is that in trying to sketch the big picture we inevitably cause specialized research to be seen from a different perspective and thus often have suggestions to make. Note that step 8 will, for example, regularly feed back into step 7.

Interdisciplinary researchers can bring several key insights to this task of evaluating previous research:

- a. If some key phenomena were excluded from previous analysis, the impact this may have had on results can be assessed. See step 6.
- b. Since no theory or method is perfect, results using different theories and methods can be critiqued from a general understanding of the strengths and weaknesses of different theories and methods, such as is provided in Szostak (2003a; 2003b; in press, d). Note again that all theories and methods are better suited to the study of some phenomena than others. Recall that the interdisciplinary researcher should seek an amalgam of different theories and methods; the goal is not to entirely discredit or exonerate any particular theory or method (though the former in particular is a possible outcome), but to identify their relative strengths and weaknesses for application to the question at hand.
- c. The particular way that a theory or method was applied by a disciplinary researcher will reflect the overall “disciplinary perspective” of the discipline in question (see step 5); this perspective can first be identified and the question of how this perspective influenced the results investigated. Bailis concurred with Newell that interdisciplinary researchers often try to synthesize across competing disciplinary perspectives. Bailis suspects, though, that interdisciplinary researchers often synthesize disciplinary insights without any explicit attention to the nature of the disciplines themselves. Newell would, I think, recognize that the latter type of research could be valuable, but that these researchers may miss important insights. This step guides researchers to worry about disciplinary perspectives but leaves open the question of their importance to a particular inquiry. A related question would look at how research on this question evolved within (or outside) a discipline, shaping the questions asked and approaches used.
- d. Familiarity with the variety of biases that can creep into both scholarly and non-scholarly research can be invaluable here. Note that while disciplines are an important source of bias, human na-

ture, individual psychologies, and the diverse roles that people play in society are also sources of bias. How likely are particular biases to have been at work, and what was their likely impact on results? Crucially, can it be shown that biases affected results? Carp, in particular, stressed the variety of biases that afflict us all. Interdisciplinary need not only master various “knowledges” but also “critiques of these knowledges” (2001, p. 88). Here, as elsewhere, interdisciplinarians could benefit from some classification; we cannot confidently interrogate others or ourselves regarding biases if we do not know what questions to ask. A tentative classification of biases has been developed in Szostak (2003b).⁴

e. Having recognized that different scholarly perspectives will shape the results of scholarly research, interdisciplinarians should question whether non-scholarly analysis provides further perspectives. If so, non-scholarly research should be evaluated as well. Both Carp and Klein urged interdisciplinarians to look beyond the scholarly literature. Newell (2001a) urged us to recognize the various biases that afflict any researcher, while avoiding the extreme postmodernist view that there is no difference between scholarly and non-scholarly research. While disciplines are far from perfect, they—along with interdisciplinary fields⁵—do impose scholarly standards on research. Just as we should evaluate the results of scholarly research, we should appreciate that non-scholarly research may (but may not) involve poorly specified or even incoherent theories, particularly ambiguous language, and questionable evidence.

Carp (2001) worried that there may be “types of knowledge” of which we are unaware. Developing and relying upon comprehensive classifications of theories, methods, and phenomena, should reduce/eliminate this problem.⁶ That is, these allow us to identify “gaps” in our understanding. Carp wondered if we could create an institutional structure that would encourage us to ask unasked questions (and generate new “objects of study” [p.85]); being aware of the full range of possibilities should be helpful here. Szostak (in press, c) argues that this comprehensive overview can be provided readily to both scholars and students.

8. *Compare and contrast results from previous disciplinary or interdisciplinary research.* This step obviously interacts with the previous one and has three aspects:

a. If different disciplines, subdisciplines, or interdisciplinary fields

(hereafter known as *communities of scholars*) reach differing conclusions, it should first be ascertained whether the difference is more apparent than real. Scholarly consensus on terminology should be sought; in its absence, scholarly analysis will need to be translated into a common vocabulary. Newell (2001) emphasized semantic difficulties, and none of the respondents doubted their importance. Carp (2001) stressed the possibility that communities of scholars will develop “artificial” constructs, which have no counterpart in the real world (pp. 91–92). Scholars might also endow real phenomena with false attributes. The list of phenomena in Szostak (2000, 2003) provides the basis for a common vocabulary, at least regarding phenomena, and provides a powerful antidote to artificiality. Dogan and Pahre (1990) and Klein (1996) note the importance of scientific “concepts” for interdisciplinary work; Szostak (2003b) suggests that those concepts that cannot be identified with some precision in terms of phenomena, causal links, theories, or methods are therefore so vague as to be of questionable scholarly utility.⁷

b. If differing results reflect more than semantic differences, the results produced by one community of scholars can be used to ask questions of another; what would have to change in order to generate similar results? If, say, a change in the assumptions driving a particular theory generated similar results to a competing theory, the interdisciplinarian can ask whether such a change seems reasonable or desirable. Newell discusses (more elsewhere than in this journal) how analysis from one discipline can shed light on analysis in another.

c. It will generally be the case that different communities of scholars have analyzed different aspects of a question; in such a case we can strive to be more precise about the range of applicability of competing theories. For example, if the question we are analyzing involves the interaction of different types of agent, we might well find that different types of theory best explain the behaviors of these different types of agent. Nobody in this debate speaks to the need to identify the particular theories’ ranges of applicability. However, unless we hope for a grand unifying theory (see 9a), this is a critical endeavor.

9. *Develop a more comprehensive/integrative analysis.* Newell (2001) confessed that we have trouble defining integration, describing how to do it, and providing successful examples (p. 18). He is undoubtedly too

humble here. Nevertheless, it seems valuable to try to flesh out exactly how integration might usefully proceed. Bailis (2001) stressed that integration may proceed quite differently depending on the question addressed. Researchers could then ascertain which types of integration are most important for particular questions. Newell stressed throughout that different disciplines will bring insight about different “facets” of an interdisciplinary topic, but is unclear about what an integrative product will look like. While this may involve some sort of unifying theory, it is more likely to involve a complex combination of theories, each shedding light on different (possibly overlapping) pieces of the puzzle. It is likely as well that analysis using different methods will be drawn upon to argue for why one theory is favored in some places, but not others. As noted above, interdisciplinarians need not take theories (or methods) as given. Indeed, interdisciplinarians may only rarely leave a disciplinary (or subdisciplinary, or even interdisciplinary) theory entirely untouched. This broad framework for integration should thus encompass the research of those more skeptical than Newell of the value of disciplines.

The following are considerations relevant to developing a more comprehensive/integrative analysis:

- a. Interdisciplinarians often hope that some grand unifying theory will fall out of their efforts. More often, it is found that multiple theories—and evidence from multiple methods—are necessary. Integration occurs when the insights of each particular theory and method are delineated, and it is shown how, in combination, they yield a better explanation than any of them in isolation. As will be seen in the next steps, the typologies of theories and methods can guide researchers as to which aspects of the broader question are best tackled with particular theories or methods.
- b. If more than one theory is involved, the range of applicability of each should be specified (as well as the evidence used to reach these conclusions). Note that multiple theories may shed light on the same phenomenon or causal link. Note also that an entirely different type of theory than that favored by a discipline *may* best fit those aspects of the question addressed by that discipline. The typology of theory developed in Szostak (2003a, 2003b) can guide researchers as to which sorts of theories are most likely to shed light on a particular question. Reliance on theories used in existing research risks missing important insights.
- c. As noted above, terms must be carefully specified; this is es-

pecially important with respect to phenomena. A common vocabulary would be invaluable here; otherwise one must speak differently to each scholarly audience.

d. If evidence from multiple methods is utilized, the strengths and limitations of these must be compared. As with theories, more than one method may shed light on a particular phenomenon or causal link. The classification of methods in Szostak (2003b; in press, d) can guide researchers as to which are most appropriate to certain types of phenomena or links.

e. Theories as applied within disciplinary research may need to be adjusted in many ways to fit within a broader analysis; assumptions may be changed or phenomena added to (or subtracted from) the analysis. The interdisciplinarian should be guided in making alterations by the criterion of whether the altered theory provides superior explanation, that is, does it accord better with the empirical evidence? How does the interdisciplinarian know what adjustments to attempt? The list of phenomena in Szostak (2000, 2003) can provide a “checklist” of possible additions to a theory. As for assumptions, logical analysis of the implications of existing assumptions, and trial-and-error analysis of alternatives, may provide the best path forward.

f. A common characteristic of interdisciplinary research (perhaps necessary, if we define interdisciplinarity in a certain way; see the discussion in step 3 above) is that it embraces a wider range of phenomena than does disciplinary research. Interdisciplinarians should strive to understand what is happening along each link among pairs of phenomena. Szostak (2003) illustrates how a series of link-based analyses can support a comprehensive understanding. When two phenomena lie within the purview of one discipline, disciplinary results can be drawn upon, as discussed above. When two phenomena are studied generally by different disciplines (or perhaps one or both is largely ignored by all disciplines) the interdisciplinary researcher must ask with what theories and methods the relationship can be investigated.

g. In addition to understanding the parts, the interdisciplinary researcher must attempt to understand how multiple causation and feedback loops interact. Newell argued that all interdisciplinary systems exhibit emergent properties that cannot be appreciated by simply adding together the disciplinary insights into various facets of

the system. As noted above, various respondents were doubtful that this is necessarily true. Nor, though, did they doubt the possibility that it might be true in some cases. And Bailis suggested that the key problem motivating interdisciplinarity is a tendency by disciplinary scholars to treat the part of the puzzle they study as the whole.

Newell put forward an even bolder hypothesis, that the links between the phenomena studied by different disciplines would reflect non-linearity. He argued that if this were not the case, and there were a simple linear relationship, this linkage would have been incorporated into disciplinary analysis. Mackey (2001) suggested that the term “non-linear” is inappropriate (p. 60); this has a precise meaning different from what Newell intended. Bailis (2001) argued that disciplines often investigate non-linearity, and interdisciplinarians investigate linearity (p. 32). (Newell responded that the examples provided by Bailis were exceptional.) Others, notably Carp (2001), questioned the very argument that disciplines would naturally absorb all linear links; Carp argued that disciplines were not logical creations but the result of a complex cultural evolution (pp. 88–89). The framework here leaves open both the question of why some links are not addressed by any discipline, and how this should best be done. These are properly empirical questions, and researchers could valuably seek to test alternative views of the nature of disciplines. Bailis wondered if Newell’s theory adds much to our understanding of how to do interdisciplinarity (pp. 38–40). Here and elsewhere we can see that it at least provides hypotheses for interdisciplinarians to test. And again competing theoretical viewpoints can help researchers in framing their analysis.

Newell (2001) suggested that integration is hard in large part because of the existence of emergent properties (p. 21). Hopefully, the detailed steps outlined above serve to show that interdisciplinary research would be difficult in any case. Nevertheless, interdisciplinarians should be encouraged not to avoid especially difficult steps.

h. While researchers will strive to identify a system of relevant phenomena, these will inevitably interact with phenomena outside the system. These other phenomena may thus have important influences on the system, which should not be simply ignored. Again, one of the key claims of Szostak (2003) is that there is some causal connection between virtually every pair of phenomena.

10. *Reflect on the results of integration.* This step should be fully embraced. Researchers should reflect upon their own biases. Obviously, having a list of potential biases to refer to (see Szostak 2003b) can be very helpful in the identification of—generally subconscious—biases. As noted above, researchers should reflect on any steps they have omitted from the interdisciplinary process, and the potential costs of the omission(s). They should reflect on the weaknesses of the theories and methods used in their comprehensive vision. They should reflect on how and why their results differ from the wider literature. They should also reflect on how their analysis might complement or contradict research on related questions (and of course, one interdisciplinary insight is that all questions are related in some way).

Both Carp and Newell described a variety of scholarly virtues, including humility and open-mindedness. This step calls on these, and also the recognition that the ability to examine oneself is often the key to ethical behavior. While Mackey (2001) emphasizes that the process by which we engage the real world may be quite different from the process by which we evaluate scholarship (pp. 66–67), it may nevertheless be useful for the present author to engage in some reflection at this point. The references to my work in the foregoing indicate that I have my own view of interdisciplinarity, but I have nevertheless striven to be evenhanded. This article makes no pretence of a broad literature review; it purposely draws only on the debate itself and my previous research (which did encompass a very broad literature search). While it can thus not claim a broad theoretical or methodological compass, it has left a clear place for this in interdisciplinary analysis. While it integrates only a handful of articles, these in turn had drawn on many lifetimes of devotion to the study and practice of interdisciplinarity. Finally, I do not pretend to have evaluated all aspects of these articles, but only those of greatest relevance to this article's "how to" focus.

11. *Test the results of integration.* Are there implications of the integrative framework that can be empirically evaluated? Can the integrative framework be applied in some way? The researcher should be careful of biasing such tests and should also be prepared to adjust the analysis in the face of new information.

Meek argued that we need complex societal institutions to cope with complex modern problems. By tackling problems one at a time, we create side effects that need to be tackled by yet other policies. Interdisciplinary research holds the promise of suggesting better solutions, but only if that research properly integrates across theory, method, and phenomena. Klein (2001) also stressed the importance of applying interdisciplinary research to

real-world problems.

12. *Communicate the results.* The researcher should try to speak both to an interdisciplinary audience and to relevant disciplinary audiences. Clarity of terminology is critical here. Careful use of jargon will also facilitate communication to the wider public.⁸

Defining Interdisciplinarity

Bailis (2001) questioned how closely Newell's definition of interdisciplinarity is tied to his depiction of how interdisciplinarity should be performed (p. 35). The easiest way to counter such an objection to a definition of interdisciplinarity is to suggest that interdisciplinarity is the performance of any of the above steps, with the caveat that we as a community achieve consensus on the proper delineation of these. Note that while some of these steps might be performed within disciplines, an effort has been made in such cases to identify the special contribution that interdisciplinarians might make. If we could indeed achieve consensus on the steps above (or some similar framework) this would be the most precise definition of interdisciplinarity possible.

It is, though, a bit unwieldy. A shorter answer to the key definitional question of *what* we integrate can be provided. We do not, in fact, integrate across disciplines *per se*, but across phenomena, theories, methods, and perspectives (while eschewing various biases—disciplinary and other). I have derived such a definition elsewhere.⁹ If we wish our definition to also embrace *how* we integrate, it may not be possible to be succinct because our answer to *how* must embrace each of the steps above, as would our answer to *why*. Still, Bailis (2001) argues that we need a better understanding of how and why to do interdisciplinarity, and I agree while hoping that the above analysis serves both goals. In any case, each of the steps above suggests a unique contribution that interdisciplinarians have to make to scholarly understanding.

Newell argues (2001) that interdisciplinary research cannot be held to the same standards as disciplinary research (p. 22). He voices this concern while speaking of emergent properties, but it can reflect a more general recognition that interdisciplinary research, in pursuing breadth, will necessarily sacrifice some depth. Interdisciplinary research can and must, however, be held to its own standards. While we cannot generally expect every step to be followed, we can legitimately ask of any piece of interdisciplinary research how well certain steps were performed, and what the costs of ignoring or poorly executing others might have been.

Acknowledgements: I would like to thank Bill Newell for not only providing the inspiration for this article, but also providing very detailed and helpful comments on an earlier draft. I would also thank the other participants in the debate for each providing much food for thought. Finally, I would thank Jay Wentworth for his characteristically kind and sage advice.

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Notes

1. Klein suggests that “how to” processes outlined in the wider literature tend to be idiosyncratic—drawn from one researcher or research project—and thus fragmentary, idealized, and prescriptive. Bailis wonders if interdisciplinarians really want to be told what to do. And Klein reminds us of the diverse motives guiding interdisciplinary research.
2. Carp (2001) notes that some would describe, say, women’s studies or Latin American studies, as inherently unique projects (p. 83). It would be useful to investigate whether research in these areas both does and should follow these steps. It may be that the relative importance of different steps varies by field.
3. Philosophers tend to emphasize three formal types of ethical analysis: *consequentialism*, which evaluates acts in terms of results; *deontology*, which seeks to identify guiding rules (such as Kant’s categorical imperative, the Golden Rule, or a set of rights); and *virtue theory*, which identifies a set of guiding virtues. Examples of each are found across diverse philosophical traditions. So too can appeals to both intuition and tradition; both of these are commonly used as ethical guidelines by individuals.
4. The classification, like many others in Szostak (2003b), relies on the five “W” questions: the “Who?” question guides us to interrogate the limited abilities and biases of individual researchers and groups; the “Why?” question leads to an examination of human motivation in general, and scientific incentives in particular; the “Where?” question points to the institutional structure in which science operates; the “When?” question primarily addresses the place of a particular piece of research within the history of its field(s); and the “What?” question deals with the vexed question of the defining characteristics of science.
5. Interdisciplinary research too needs to pursue certain standards, such as clearly specified theories, methods, and evidence, which provide insight into a question of importance. Questions of appropriate scholarly standards are addressed in Szostak

(2003b; in press, c).

6. Szostak (2003b; in press, d) argues that scholarly theories should engage five questions: who is the agent, what “action” does the agent perform, what decision-making process is involved, what timepath is envisioned, and what is the range of applicability of the theory? This list of questions allows shortcomings in non-scholarly theory to be quickly identified. The lists of phenomena and methods referred to above are hopefully exhaustive, and thus should subsume non-scholarly as well as scholarly research. In the case of methods, we would want to investigate how carefully these were applied.

7. Think of “patriarchy,” a term that implies, at least, a set of realizations with respect to social, cultural, and political phenomena. If these are not specified, scholars will not know when patriarchy is observed. Nor will they be able to identify how patriarchy works, and thus might be transformed; this can only come from understanding causal links such as those between cultural attitudes and political institutions supportive of patriarchy.

8. Marcia Bundy Seabury is preparing a set of guidelines for interdisciplinary scholarship. I have benefited from reading early drafts of this work. While her focus is upon evaluating the quality of scholarship, and particularly scholarship about interdisciplinary teaching, she naturally touches on many of the points made here.

9. In Szostak (in press, c), I suggest that we can derive a definition of interdisciplinarity deductively by looking at the characteristics of disciplines identified by previous researchers, including Klein. That is, interdisciplinarity must involve doing things that disciplines by definition do not. This means drawing on multiple theories, methods, phenomena (more than encompassed by one discipline), and/or perspectives (I identify philosophical orientation as a key component), while eschewing the “rules of the game” by which incentives are provided to disciplinary researchers.

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