

# THE STATE OF THE FIELD: Interdisciplinary Theory

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**Abstract:** This chronological overview of the development of interdisciplinary theory starts with the pre-cursors of theory: the development and elaboration of the definition of interdisciplinary studies, influential but problematic images of interdisciplinary studies proposed by Donald Campbell and Erich Jantsch, and best practices in interdisciplinary studies identified through AIS. It continues with a review of the motivation behind a theory of interdisciplinary studies, the controversy it engendered, and an assessment of what remains to be done. It concludes with the challenges to theory posed by new types of interdisciplinary studies, especially transdisciplinary studies and the science of team science.

**Keywords:** interdisciplinarity, interdisciplines, best practices, interdisciplinary process, transdisciplinary, science of team science

Now that more than a decade has passed since the 2001 publication of “A Theory of Interdisciplinary Studies” in *Issues in Integrative Studies*, it seems appropriate to look back at how far interdisciplinarians have come in the development of interdisciplinary theory, with an eye to what remains to be done and where we seem to be heading. Such an overview can be useful, not only in gauging the development of interdisciplinary studies as a profession, but also in guiding the design and teaching of interdisciplinary courses. To promote those ends this article links changes in our conception of interdisciplinary theory to shifts in the focus of the Association for Integrative Studies, recently renamed the Association for Interdisciplinary Studies. And it probes the implications for classroom teaching of each theoretical development.

The article is divided into three sections, presenting what I see as three chronological stages in the development of interdisciplinary theory. The first, labeled “pre-theory,” focuses on definitions, influential images, and

best practices. The second, labeled “theory,” focuses on modifications, application, testing, and vetting of “A Theory of Interdisciplinary Studies.” The third section, labeled “expanding theory,” focuses on the anticipated impact on interdisciplinary theory of enlarged conceptions of interdisciplinarity, such as those espoused by (often European) transdisciplinary and by the science of team science.

This article is concerned with interdisciplinary studies as it is understood within the Association for Interdisciplinary Studies (see next section). That understanding was a minority viewpoint when AIS was founded, though it has become widely and prominently—though by no means universally—accepted in American higher education. Thus, “theory” refers in this article to theory of that particular conception of interdisciplinary studies. The objective of theory here is to explain why interdisciplinary studies should be so conceived and practiced.

## Pre-theory

### *Definitions:*

The initial focus of AIS was on a definition for “interdisciplinary studies.” The objective was to distance AIS from those who purported to engage in interdisciplinary teaching without integration or whose courses tended to reject disciplines rather than draw on them. Discussion of a theory of interdisciplinary studies would have seemed premature at that point. Until there was agreement on what interdisciplinary studies is, there was no point in discussing why or how it works. Clarifying the definition of interdisciplinary studies, then, was a prerequisite for the development of theory.

In 1979, the professional literature on interdisciplinary studies was quite modest (see Mayville, 1978). The term was used widely, but often quite casually in discussions of higher education reform. A few authors, however, took the approach favored by the founders of AIS. Notably, Richard Meeth (1978) defined “interdisciplinary” (courses and programs) as “attempt[s] to integrate the contributions of several disciplines to a problem, issue, or theme from life,” and he then defined “integration” as “bringing interdependent parts of knowledge into harmonious relationship” which “involves relating part to part, part to whole, and whole to part” (p. 10). And Earl McGrath (1978) felt “The chief purpose of interdisciplinary work [is] to integrate relevant knowledge around a significant issue” (p. 8). Like

the founders of AIS McGrath lamented that “The largest percentage of interdisciplinary courses developed by the colleges . . . involved no real merging of subject matter except in the catalog” (p. 7). Mayville’s own definition of “interdisciplinary studies” was more vague—“interaction among two or more different disciplines [that] should include the idea of integration of concepts, methodologies, procedures, epistemology, terminology, and data” (1978, pp. 1-2)—but at least he highlighted integration and disciplines.

The first published article to reflect AIS discussions of interdisciplinarity was “Defining and Teaching Interdisciplinary Studies” (Newell & Green, 1982). Its definition of “interdisciplinary studies” was “inquiries which draw critically on two or more disciplines and which lead to an integration of disciplinary insights” (p. 24). As with McGrath and Meeth, this definition focused on disciplines and integration, but it was explicit and clear about what gets integrated (insights), and it problematized the process of drawing insights from disciplines (critically). Note also that this definition was in two parts—“drawing” was distinct from (and necessarily prior to) “integrating”—which foreshadowed AIS discussions of the interdisciplinary process that took place decades later.

By the mid-1990s when the Association of American Colleges and Universities undertook its update of Arthur Levine’s *Handbook of the Undergraduate Curriculum*, interdisciplinary studies merited its own chapter, AIS leaders (especially Julie Klein) were the obvious choice to write it, and the AIS conception of interdisciplinarity had become widely accepted. The definition in the “Advancing Interdisciplinary Studies” chapter was “A process of answering a question, solving a problem, or addressing a topic that is too broad or complex to be dealt with adequately by a single discipline or profession . . . IDS draws on disciplinary perspectives and integrates their insights into a more comprehensive perspective” (Klein & Newell, 1997, pp. 393-394). While it incorporated elements from the definitions of Meeth, McGrath, and Newell and Green, three key elements were added: (1) IDS was explicitly identified as a process; (2) the justification for IDS was identified as breadth or complexity; and (3) the outcome of IDS was characterized by comprehensiveness.

A decade after the publication of “Advancing Interdisciplinary Studies,” a review of recent definitions of “interdisciplinary studies” identified the common elements in what had become an emerging consensus definition. Those are a substantive focus that exceeds the scope of a single perspective, an identifiable process that involves drawing explicitly on the disciplines

(which provide insights into the specific substantive focus), and integration (to solve the problem, resolve the issue, address the topic, answer the question, explain the phenomenon, or create a new product). Key unresolved definitional issues remained: Does IDS manifest itself differently, depending on its focus and objectives? Should IDS draw on perspectives outside the disciplines or the academy? How much complexity or breadth is needed to justify IDS? Is complexity the sole rationale for IDS? Are insights all that IDS draws from the disciplines and integrates? Must full integration be achieved for a study to be interdisciplinary, or would mere progress towards that goal suffice? (Newell, 2007)

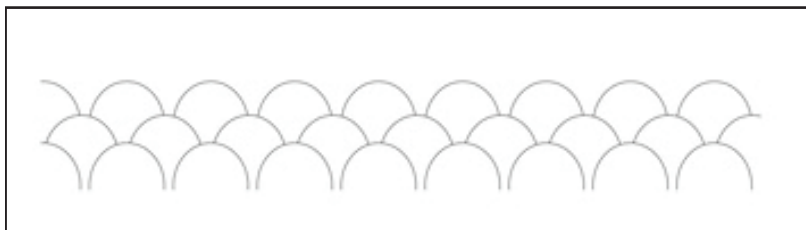
While such issues continued (and will continue) to be debated by interdisciplinarians, the definition of “interdisciplinary studies” had been sufficiently developed and elaborated by the start of the new millennium to serve as a basis for the development of interdisciplinary theory.

### *Influential Images:*

Two images dominate the history of interdisciplinary thought. One is the fish scale model used by Donald Campbell to depict how interdisciplines can overlap disciplines to produce interdisciplinary studies (Campbell, 1969, p. 4). The other is a diagram used by Erich Jantsch to depict the relationships between multidisciplinary, pluridisciplinary, crossdisciplinary, interdisciplinary, and transdisciplinary studies (Jantsch, 1972, p. 107). Campbell’s fish scales served as the motif for Julie Klein’s first book (Klein, 1990) among other uses, and Jantsch’s diagram (or the hierarchy it presents) has appeared in numerous publications on interdisciplinary studies over the last 40 years.

Mental images and models matter. For some, they are the primary means of taking in information. For most of us, they serve as a framework for organizing new information and a gauge for evaluating it. As such they can be powerful tools that shape our thinking for better or for worse. What is potentially worrisome is that because they are perceived directly, not through the medium of language, images often do not get vetted as written ideas do. The result can be insidious: An image may shape our thinking more than we realize, yet not stand up to close critical scrutiny. It is my contention that Campbell’s image has made it more difficult to arrive at our current conception of interdisciplinary studies and thus retarded the development of interdisciplinary theory. The impact of Jantsch’s image was more mixed—it aided the growth of modern-day interdisciplinarity in important ways, but

inhibited it in other ways.



**Figure 1:** Campbell's Fish-scale Model of Interdisciplinary Studies.

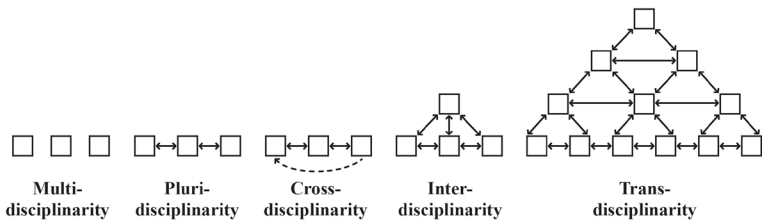
In Campbell's image, each scallop represents a different discipline (in the bottom row) or interdiscipline (higher rows). The gap between the subject matter of two adjacent disciplines is represented by the space between scallops in the bottom row. Campbell asserts that scholars respond to the gaps by developing interdisciplines specializing in those subject matters. The gaps in subject matter coverage between those interdisciplines then attract other scholars who develop a new set of interdisciplines, and so on. Thus the academy as a whole achieves interdisciplinarity.

I suspect that Campbell's image of interdisciplines filling in gaps between disciplines is the source of the oft-made claim in years past that interdisciplinary studies takes place in the "interstices between disciplines." For decades, one of my first challenges as a consultant leading faculty development workshops on interdisciplinary studies was to disabuse faculty members of this notion. In fact, disciplines do not have gaps between them; they overlap. As new subject matter opens up, multiple disciplines rush in to claim it. Thankfully, references to interstices have finally faded away in the writing of interdisciplinary neophytes.

Underlying Campbell's image is a conception of interdisciplinary studies quite different from today's. For purposes of comparison with the Klein-Newell definition, one might say that Campbell defined interdisciplinary studies as an array of narrowly-focused interdisciplines that, just like the disciplines, seek to fill knowledge gaps rather than address problems, issues, or questions. Individual interdisciplines draw information, data, techniques, tools, perspectives, concepts, and/or theories from two disciplines or previously-established interdisciplines and integrate them into a new perspective with a unique focus. Together, interdisciplines and disciplines combine to produce comprehensive knowledge.

Thus, for Campbell interdisciplinary studies is systemic, not intentional,

carried out by the academy as a whole, not by individuals or teams, and retains the reductionist mindset and the goal of producing basic knowledge (as opposed to solving complex problems) that characterizes the disciplines. In short, Campbell's conception of interdisciplinary studies bears little relationship to our current understanding, and the fish scale image contributed nothing to its development. Rather, it made it harder to move beyond disciplinary thinking, and harder to claim a role for interdisciplinarians. Indeed, Campbell's conception was precisely the one held by provosts and deans that led to the demise of many prominent interdisciplinary studies programs in the new millennium (Augsburg & Henry, 2007).



**Figure 2:** Jantsch's Hierarchy of Studies Transcending Disciplinarity

Jantsch's diagram sets out a knowledge-production hierarchy of cooperation and coordination among disciplines. By coordination he means purposive control of a cluster of disciplines from a higher level in the hierarchy, whereas cooperation involves collaboration among disciplines on the same level. Each term in the diagram represents a different organizational principle for knowledge production. In multidisciplinary, disciplines function side by side without cooperation or coordination, each in pursuit of its own distinct goals. In pluridisciplinarity, clusters of related disciplines cooperate without coordination in pursuit of their separate goals. In crossdisciplinarity, the approach and goals of one discipline are imposed on other disciplines at the same level. In interdisciplinarity, a coordinating group at a higher level modifies a cluster of related disciplines so they use compatible terminology in pursuing their different objectives, guided by an overall purpose set by the coordinating group. And in transdisciplinarity each higher-level coordinating group further modifies the disciplines under it so they think as well as speak compatibly, and those bi-level interdisciplinary clusters are combined into a multi-level cluster of clusters that includes all disciplines and addresses all socially relevant problems. Thus, interdisci-

plularity is the principle for organizing disciplines to address a particular societal problem, whereas transdisciplinarity is the principle for organizing interdisciplinary and disciplinary clusters to address the full array of knowledge needs of society.

Jantsch sees interdisciplinary studies as an organizational principle, not an activity or process; it is a way for disciplines (e.g., disciplinary departments) to relate to each other, not a way of thinking. Like Campbell, he sees the actors in the knowledge production system as disciplines, not individual interdisciplinarians or interdisciplinary teams. Unlike Campbell, he sees interdisciplinary studies as intentional and purposive (i.e., focused on important societal problems, not on basic research). Where Campbell sees the creation of new interdisciplines as the dynamic element in the system, Jantsch sees the dynamism growing out of modifications of disciplinary concepts, principles, boundaries, and interfaces by higher-level coordinating groups, resulting in emergent properties of the system.

For purposes of comparison with the Klein-Newell definition, one might say that Jantsch defines interdisciplinary studies as follows: Interdisciplinary studies constitutes a portion of an ideal knowledge system for addressing societal problems that are too broad or complex to be dealt with adequately by a single discipline or profession. Interdisciplinary and transdisciplinary studies jointly coordinate and modify disciplines—interdisciplinary studies by getting them to speak the same language, transdisciplinary studies by getting them to think compatibly—and create new disciplines so that the modified and new disciplines (not interdisciplinary or transdisciplinary studies) can jointly solve these problems.

In his focus on cooperation and coordination, his emphasis on modifying the languages of disciplines, and his identification of major societal problems as the province of interdisciplinary studies, Jantsch contributed to the development of the current understanding of interdisciplinary studies. But his conception of interdisciplinarity as an organizational structure, not a cognitive/intellectual activity or process, ended up playing into the hands of administrators who assume that reorganization is all that is required to implement interdisciplinary studies and that faculty development or training in interdisciplinarity is a luxury. And his presumption that disciplines, not individuals or teams, carry out the real intellectual work of interdisciplinary studies has provided support for skepticism towards interdisciplinary courses and the development of an interdisciplinary studies profession.

*Best Practices:*

In the late 1980s an AIS task force report started the process of moving discussion from definitions to best practices. It encouraged

interdisciplinary courses to focus on a single issue/problem/question, . . . make explicit use of disciplines or schools of thought, . . . examine the perspective or worldview underlying each discipline or school of thought and its assumptions, . . . ask students to integrate the insights of disciplines or schools of thought into a more comprehensive perspective on the topic, [and] . . . familiarize students with various holistic perspectives such as structural functionalism, Marxism, ecology, and systems theory. (Philosophy Network, 1988, pp. 2-3)

The interspersed course examples and rationales for each point suggested additional best practices as well:

An integrative course “covers” reductionist perspectives . . . the way a disciplinary course covers subject matter, and the topic needs to be quite focused in order to allow enough time for each perspective; . . . We promote tolerance of ambiguity when we show students that the disciplines’ insights are grounded in compelling but different arguments. When students are exposed to more than one integrative course, they can even come to celebrate diversity or pluralism as they learn that any one reductionist analysis is valuable but limited and seek out others; . . . We can best promote critical thinking and sensitivity to bias when students are able to assess the assumptions underlying each discipline’s insights. We can help to demythologize disciplinary expertise when students can see the limitations posed by these assumptions; . . . Through confronting contradictory as well as complementary insights of the various disciplines and the assumptions underlying them, students can be encouraged in holistic or synthetic thinking. (Philosophy Network, 1988, pp. 2-3)

By the early 1990s the typical AIS conference presentation focused on implementing, not conceptualizing, interdisciplinary studies. Interest had shifted from definitions to best practices. Insights into best practices came not only from firsthand teaching experience at a variety of institutions, but also from participation in the Institute in Integrative Studies (which drew dozens of faculty to Miami University for observation of the Western Col-



lege Program and then summer workshops), and especially from the consulting experience of a growing number of AIS leaders. Thus, the process of identifying best practices was inductive not deductive, based in experience not theory. The test of a best practice was pragmatic—whatever gave the most desirable results. For teaching, it was student learning outcomes; for research, it was novel insights or successful application; and for administration, it was continued program survival (or even expansion).

My own top 10 list of best practices for conducting and teaching interdisciplinary studies would be the following:

- Assume every disciplinary perspective has at least a kernel of truth.
- Look for strengths in arguments you dislike and weaknesses in those you like.
- Seek commonalities, i.e., win-win situations, not compromises.
- Think inclusively (both/and) as well as dualistically (either/or).
- Strive for balance among disciplinary perspectives.
- Be responsive to all perspectives but dominated by none of them.
- Think of an interdisciplinary course as covering perspectives the way disciplinary courses cover subject matter.
- Be explicit in drawing insights from disciplines.
- Be explicit about interdisciplinary process.
- Serve as a model interdisciplinarian for students; you can be a guide or coach but not the expert.

The more comprehensive list of best practices in the Appendix reflects the richness of discussions at AIS conferences. But it raises questions of criteria, consensus, and rationale. How do we know these are best practices? How were they vetted and by whom, according to what standards, with what reliability? Is the list partial or complete? Can an underlying rationale be provided for the selection of best practices?

Questions such as these, and similar questions about the emerging consensus definition of interdisciplinary studies led me to search for a theory of interdisciplinary studies. The profession needed a deductive as well as

inductive strategy for evaluating what we thought we knew about interdisciplinary studies and for guiding future research. To edify practitioners and answer critics, it needed a rationale grounded in more than experience, and it needed an intellectual framework that would pinpoint new areas for research. In short, what was needed was a theory to guide not just our evaluation of definitions and the best practices identified so far, but also our search for additional best practices and attempts to expand the definition of interdisciplinary studies.

## Theory

### *Broaching a Theory:*

The story of the development of my theory of interdisciplinary studies has already been told elsewhere (Newell, 2011b), so this section starts with the theory itself. Unlike disciplines, interdisciplinary studies as we now understand it is characterized not by a particular subject matter, but rather by its distinctive approach or process, which both embraces and transcends the disciplines. Any theory of interdisciplinary studies, then, needs to explain that process. The theory I proposed in 2001 did so by working backwards from identifying the nature of the “objects” of interdisciplinary study (i.e., problems, issues, questions, or phenomena) to explaining the nature of the process by which those objects are studied.

The central insight behind the theory is that the objects of interdisciplinary studies are all complex—indeed, that complexity is both a necessary and a sufficient condition for interdisciplinary studies. That is, interdisciplinary studies deals only with phenomena (let’s say) that are complex, and all complex phenomena require interdisciplinary study.

To explain interdisciplinary process, then, one must understand the inherent nature of complexity itself. At the turn of the millennium, the study of complexity (i.e., complex systems theory) was in its infancy, so there were many competing and evolving conceptions of complexity available. The good news is that one of them fit rather nicely with the ontological presumptions of interdisciplinarians; it corresponded to their implicit understanding of the nature of the world they were studying. In this conception, complex systems have lots of components/elements/variables that are linked/interconnected/interrelated (some strongly, others weakly), often organized in sub-systems. Linkages, especially within subsystems, can be fairly linear (i.e., proportionate), but enough are nonlinear (i.e., disproportionate, some

highly so) to make the pattern of behavior of the overall system emergent and only quasi-stable and quasi-predictable as well as subject to occasional periods of rapid transformation (so-called bifurcation points).

It was, and remains, my contention that the sort of interdisciplinary process hinted at in the Klein-Newell definition and spelled out in my theory can be derived from the properties of such complex systems. That is, interdisciplinary studies process can be understood as the appropriate academic response to the nature of the complex phenomena it studies. And understanding of such complex phenomena requires just such a process. Thus, the theory not only explains but also justifies the interdisciplinary process.

### *Responses:*

Turning from the theory itself to the initial responses to it within the interdisciplinary studies profession it would be fair to say that the applause was not exactly deafening. The reasons varied from one respondent to the next—it's not the first theory, it's not a theory at all, its conception of complex systems is wrong, its conception of interdisciplinary studies is wrong, its ontology is wrong, its treatment of disciplines is misguided, its reasoning is flawed, it's unworkable, and it's limiting, among many other objections—but altogether the "Responses to Newell" in the 2001 volume of *Issues in Integrative Studies* reflected a less than enthusiastic endorsement. My 12-page "Reply to the Respondents" could address only a few key issues, clarifying my argument perhaps but probably not changing many minds.

In light of the negative initial response to the theory, the extent of subsequent use of the process set out in that article (and occasionally even of the theory itself) was quite unexpected. The 2002 volume of *Issues in Integrative Studies* included an article by Rick Szostak proposing a variant of the process, and his exchange with J. Linn Mackey continuing the debate started in the 2001 volume. The next two volumes each included an article explicitly grounded in the theory and another in the process. Meanwhile, papers and discussions at AIS conferences increasingly made references to process or theory. Perhaps the high profile and intense energy of the debate over the theory had enlivened the conferences. Outside AIS, a series of major national reports such as *Facilitating Interdisciplinary Research* (NAS, 2005) not only embraced a variant of the Klein-Newell definition but also foregrounded complexity as the primary driver of interdisciplinary research, though they overlooked interdisciplinary process completely. With the publication of his *Interdisciplinary Practice* (Repko, 2005) followed by *Interdisciplin-*

*ary Research: Process and Theory* (Repko, 2008) and then its second edition (Repko, 2012), Allen Repko introduced a large and rapidly widening circle of students and their instructors to his own variant of interdisciplinary process. Each textbook in turn devoted more attention to complexity as a rationale for interdisciplinarity, but identified several other drivers as well. *Case Studies in Interdisciplinary Research* (Repko, Szostak, & Newell, 2012) demonstrated the utility of Repko's variant of interdisciplinary process for guiding research in a range of fields. And a popular series of "Teaching with Repko" sessions at AIS conferences explored its utility in the classroom.

### *Taking Stock:*

There appears to be a narrowing of focus on a cluster of similar candidates for interdisciplinary process among scholars interested in that process, but my impression is that interest in interdisciplinary process is quite uneven within AIS and yet to take hold outside AIS. It is neither surprising nor disturbing that AIS is taking leadership in promoting interdisciplinary process, much as it did in working on the definition of interdisciplinary studies and on identifying interdisciplinary best practices (especially in teaching). However, even though there is widespread agreement (with no dissenting voices of which I am aware) that complexity is at least a major driver of interest in interdisciplinarity, there appears to have been little if any attention paid since my 2001 article to the characteristics of complexity and how they relate to interdisciplinary process.

As a result, it is difficult to vet the different versions of interdisciplinary process. Repko's version has become the de facto "lead model" largely by default. We know from experience that small differences in definitional starting point can lead to big differences in practice; the same presumably holds for small differences in process. For example, my version of interdisciplinary process, grounded in the nature of complexity, includes a separate step of identifying linkages between variables or phenomena studied by different disciplines, as no single discipline is likely to have studied them. Repko's process, however, makes no mention of these linkages between the subsystems studied by different disciplines. The difference in scholarly activity utilizing each process could turn out to be the difference between comprehensive understandings that solve complex problems and those that fail to do so.

Nor has any scholarly attention been paid so far to applications of theory or process to anything other than interdisciplinary research. In addition to

adjudicating remaining differences in definition, interdisciplinary theory (out of which can come agreement on interdisciplinary process) needs to be applied to the following:

- Evaluating (and justifying where warranted) individual interdisciplinary courses as well as the general direction these courses have taken in recent years.
- Explaining what interdisciplinary studies is, not just its consequences.
- Understanding, explaining, and justifying (when it is warranted) interdisciplinary practices (what we do) and interdisciplinary best practices (what we should do).
- Demonstrating the need for interdisciplinary studies and interdisciplinary programs.
- Establishing a credible basis for rigorous standards and assessment that can bring respect as well as popularity to interdisciplinary studies.
- Establishing a basis for sequences of courses, and for determining what is entailed by depth and sophistication.
- Identifying roles for professional interdisciplinarians, not just for interdisciplinary fields and interdisciplines.
- Justifying a focus on overlap in (not gaps between) disciplines.
- Justifying a focus on integration by interdisciplinarians, not by systems or interdisciplines.

## Expanding Theory

### *New Types of Interdisciplinary Studies:*

When AIS was founded in 1979, the locus of interdisciplinary activity in the United States was in education, mostly in undergraduate liberal arts courses, especially in the humanities and soft social sciences. The main issue dividing AIS from kindred organizations was whether interdisciplinary studies should be carried out by transformed disciplinarians or by professional

interdisciplinary. All that has changed today, and the pace of the change has caught many of us by surprise. Even though we have barely started to get serious about interdisciplinary process, much less interdisciplinary theory, we now need to re-evaluate and perhaps expand our understanding of interdisciplinary process and theory in light of these recent developments.

Today, while the number of undergraduate interdisciplinary courses continues to grow, the primary locus of interdisciplinary activity and funding has shifted from teaching to research, from the undergraduate to the graduate level, from the humanities and soft social sciences to the natural sciences and medicine (and, to a lesser extent, the hard social sciences), from an individual to a team activity (often geographically dispersed), and from the ivory tower to the real world. The teams that carry out interdisciplinary research are comprised of open-minded but still mainstream disciplinarians rather than interdisciplinary, and increasingly include (especially outside the United States) non-academics as well as academics. The resulting challenges to interdisciplinary process and theory are epitomized by two new interdisciplinary movements—transdisciplinary studies and the science of team science.

### *Transdisciplinary Studies:*

Transdisciplinary, especially in Europe and Australia, focus their research on the development of public policy on complex real-world problems and conduct their research in collaboration with stakeholders and institutions/agencies with their own interests, perspectives, and insights. Transdisciplinary are interested in implementation as much as understanding, in experience-based context-specific knowledge as much as academic knowledge, and in benefits to society as much as to the disciplines.

There is a burgeoning professional literature, though researchers in transdisciplinary studies operate largely without benefit of knowledge of interdisciplinary process or theory. Interdisciplinary need to learn from these professionals and their literatures, incorporating what we learn into an appropriately expanded conception of interdisciplinary studies and an enriched theory and process. And AIS needs to contribute that enlarged understanding of interdisciplinary theory and process to the study and practice of transdisciplinary policy making and implementation. One forum for developing such an enlarged understanding is INIT, the International Network for Interdisciplinarity and Transdisciplinarity that AIS leaders helped found in 2011.

The key challenge we face is whether to expand our definition of interdisciplinary studies and enlarge our conception of interdisciplinary process

to accommodate transdisciplinarity, or to use them to distinguish interdisciplinarity from transdisciplinarity. (A theory of interdisciplinary studies as a response to complexity already fits nicely with a transdisciplinary view of the world.) If we wish to expand and enlarge, how far should we go? Specifically, transdisciplinarity pushes us to rethink the exclusive reliance of interdisciplinarity on disciplines, the focus of interdisciplinarity on understanding over application, the locus of interdisciplinary activity in the academy instead of the real world, and the conception of interdisciplinarity as intellectual inquiry rather than political or social activity.

### *Science of Team Science:*

Thanks to annual agency grants and corporate investments reaching half a billion dollars in recent years, interdisciplinary team science research has become more visible than undergraduate interdisciplinary education in American universities. Most of this more-or-less interdisciplinary research is carried out in teams whose participants, like European transdisciplinaryians, are largely unaware of interdisciplinary process, let alone theory. The substantial body of professional literature on team research focuses instead on the operation of teams in general, especially organization and communication. While more recent literature pays attention to the special organizational and communication challenges facing teams that are interdisciplinary, little if any attention is paid to the nature and challenges of interdisciplinarity. A new but vibrant professional conference, SciTS (Science of Team Science), has become a key player in a field dominated until recently by funding agencies, especially the National Institutes of Health, and corporate R&D. As with transdisciplinary studies, interdisciplinarians need to learn from these professionals and their literature, incorporating what we learn into an appropriately expanded conception of IDS and an enriched theory and process. And we need to contribute our enlarged understanding of interdisciplinary theory and process to the study and practice of team science.

The key challenge we face is whether to recast interdisciplinary process as a team as well as an individual activity, or to retain current conceptions to differentiate interdisciplinary studies from team science. (The Klein-Newell definition of interdisciplinary studies can already accommodate interdisciplinary team research. And, as with transdisciplinary studies, theory that presents interdisciplinarity as a response to complexity is already pretty consistent with the worldview of scientists engaged in team research.) Were we to expand our conception of interdisciplinary process to include team-

work, we would lose some of the focus on interdisciplinarity itself—it might become difficult to disentangle problems of teamwork from problems of interdisciplinarity—and we would be drawn into the messy world of interpersonal dynamics, motives other than discovering truth, and problems of communication and technology. Were we *not* to do so, we would run the risk of floating into a back eddy of today's torrent of interdisciplinary studies, and becoming increasingly irrelevant as a result.

## Conclusion

The development of interdisciplinary theory is central to the maturation of the field of interdisciplinary studies and to the perceived legitimacy of the interdisciplinary studies profession. Without it, I see little prospect for demonstrating a role for professional interdisciplinarians as the field of interdisciplinary studies becomes increasingly dominated by disciplinarians. At a more operational level, we need theory to guide our search for additional best practices and our vetting of them, and for selecting among variants of interdisciplinary definitions and process; the days of ad hoc-ery are past. In fairness, AIS has made a lot of progress in the last decade in discussing interdisciplinary process, after focusing on definitions and best practices in the previous two decades. But the explosion of activity outside AIS in team science and transdisciplinary approaches to complex real-world problem-solving, especially in the last decade, makes it imperative that we now move quickly to develop interdisciplinary theory so that our definitions, best practices, and process can be reevaluated and expanded as appropriate to contribute to and benefit from these major new interdisciplinary activities. The alternative is to find ourselves on the sidelines rather than in the forefront of interdisciplinary studies.

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## APPENDIX

The following list is adapted from the handout accompanying my June 16, 2011, presentation at the founding seminar of INIT (the International Network of Interdisciplinarity and Transdisciplinarity) held in Utrecht, Netherlands. It includes my top 10 list above.

### Commonly Identified Best Practices in Interdisciplinary Studies

#### A. Research

- Choose a topic broad enough to include all relevant aspects of the problem, yet focused narrowly enough to include all relevant disciplinary perspectives, and to ensure disciplines engage, not talk past, each other.
- Strive for adequacy in the narrowly relevant concepts and theories of each discipline, as well as a feel for its perspective.
- Assume every disciplinary perspective has at least a kernel of truth.
- Seek out diversity in perspectives for a richer and more comprehensive understanding.
- Bracket and set aside or suspend personal convictions.
- Look for strengths in arguments you dislike and weaknesses in those you like.
- Seek commonalties not compromises, i.e., win-win situations.
- Think holistically, contextually, and systemically.
- Think inclusively (both/and) as well as dualistically (either/or).
- Embrace contradiction--ask how it can be both.
- Recognize that interdisciplinarity derives its energy, challenge, and richness of understanding from the tension between disciplinary perspectives.

- Look for unexamined linkages and unexpected effects.
- Expect multiple causes and effects.
- Strive for balance among disciplinary perspectives.
- Integrate as you go (instead of waiting for all disciplines' insights).
- Value intellectual flexibility and playfulness.
- Seek an understanding that is equally responsive to the contributing theoretical perspectives and to the empirical pattern of behavior.
- Be responsive to all perspectives but dominated by none of them.

#### B. Teaching

- In assembling a course design team, work back from outcomes sought from that slot in the curriculum to determine which disciplines to include.
- Choose team members with an eye to personality as well as expertise.
- In creating a new course treat the topic as tentative, i.e., subject to re-evaluation at each step in the design process.
- Choose the course topic with an eye to faculty and student interests as well as curricular mandates.
- Select a substantive topic that provides context for abstract issues, glue for the course, and motivation for students.
- Identify a subtext as well as a topic, i.e., an abstract issue of which the concrete topic is a particular embodiment.
- Select disciplines for their contribution to the subtext as well as the topic.
- Think of an interdisciplinary course as covering perspectives the way disciplinary courses cover subject matter.

- In team-teaching or a multi-section course taught by different instructors, set up a faculty seminar that runs parallel to the course.
- Be explicit in drawing insights from disciplines.
- Using concepts and theories as well as perspectives, illuminate the disciplines from which insights are drawn.
- Present concepts and theories in the same depth as in a disciplinary course at that level.
- Choose a mix of readings and lectures for each discipline that reveals its insights into the substantive topic, the concepts and theories underlying those insights, and its perspective and underlying assumptions.
- Be explicit about interdisciplinary process.
- Explain how to integrate and provide examples—integration is neither self-evident nor appropriately left to a final culminating paper.
- Serve as an advocate as well as a critic of each discipline.
- Serve as a model interdisciplinarian for students; you can be a guide or coach, but not the expert.
- Different perspectives are valued (albeit critically) in class discussion as in IDS process: Explain that students have an obligation to the rest of the class to participate.
- Permit class discussion to move freely (among insights, disciplines, comparison with those of previous weeks, common ground, integration, personal as well as societal application, and interdisciplinary process).
- Treat class discussion as a collaborative joint exploration, not a competition.
- Reveal pedagogical objectives to students (so they can be co-conspirators).

- Foreshadow, contextualize, revisit, review, and summarize so students do not get lost in an unfamiliar process.
- Come up with evaluative assignments that are relational, applied, novel, active, and connected to students' lives.
- Include in the syllabus a course description and rationale, an explanation of interdisciplinarity, course objectives grounded in the above, and weekly if not daily topics organized to make course structure apparent, as well as reading assignments and evaluative experiences.

### C. Administration

- Treat team-teaching and faculty seminars as faculty development.
- Reexamine every step in personnel process (from advertising positions to interviewing and hiring, appointment letters, promotion and tenure procedures, and annual salary reviews) to ensure they reward interdisciplinary teaching/research.
- Recognize that curricular experimentation requires space to fail without penalty.
- Provide appointment flexibility to allow faculty to follow evolving interests.

(Newell, 2011a)