

“Advancing” Interdisciplinary Studies: The Boundary Work of Integrating, Complexifying, and Professionalizing

by

Julie Thompson Klein
Professor of Humanities Emerita, English Department
Wayne State University

Abstract: This article places William Newell’s work on interdisciplinary studies (IDS) within the larger landscape of definitions, theories, and practices of interdisciplinarity. It begins by benchmarking three of his major contributions to the field of interdisciplinary studies read in the context of expanding literature on related topics: specifically his efforts to make integration the foundation of process-based best practices, to establish a theoretical framework grounded in complexity, and to professionalize the field of IDS. It then examines two challenges to AIS today that Newell alerted members to in a 2013 reflection on the state of the field – transdisciplinarity and team science – followed by added insights from two areas – policy sciences and interprofessionalism. The article closes by reflecting on current conflicting priorities, renewed debate on the relationship of disciplinarity and interdisciplinarity, and efforts to explore intersections of multiple organizations vested in inter- and transdisciplinarity today.

Keywords: interdisciplinarity, transdisciplinarity, disciplinarity, integration, complexity, critique, relationality, translation

The term *Festschrift* derives from a German word meaning “party-writings.” *Festschriften* are usually published upon an individual’s retirement or other notable occasion. For William Newell, the event was stepping down as Executive Director of the Association for Interdisciplinary Studies (AIS). The genre takes many forms. Some pay homage to work over a lifetime, others highlight particular accomplishments, and others yet situate an individual’s work with the history of a field. This contribution does the latter. It takes the title of Klein and Newell’s (1996) account of interdisciplinary studies (IDS) in the *Handbook of the Undergraduate Curriculum* as an index of change. When Jerry Gaff invited them to co-author a chapter on IDS they believed the field had reached a point that the title should include the

word “Advancing” instead of “Developing.” Accounting for its progress they cited a growing number of contexts, benchmarked best practices, anchored teaching and course design in the concept of integration, and articulated criteria for evaluation. In order to explain the heterogeneity of activities, Newell suggested complexity as a metaphor for the changing structure of higher education. Simple systems can have multiple levels of connection, but they operate according to a single set of rules. In contrast, complex systems are not hierarchically structured. They obey multiple logics, have synergistic effects, and even exhibit a chaotic element. Addressing implications for interdisciplinarity, Klein and Newell (1996) explained that IDS was typically located within a simple system of familiar structures: ranging from free-standing institutions, autonomous colleges, centers, departments, and programs to general education, individual courses, self-designed studies, study abroad, and internships. A variety of other activities, though, were gaining visibility including learning communities, research projects, shared facilities, schools of thought, enhanced disciplinary curricula, collaborative work, networks, and hybrid communities.

When a tribute to Newell appeared in the AIS newsletter to mark the occasion of his retirement, former presidents and current members of the Board of Directors revealed a more personal picture of his contributions to advancing the field of IDS. They praised his leadership of the organization, generous mentoring of individuals, and numerous consulting trips to help campuses plan, implement, and sustain programs (Klein, 2016). This contribution to the *Festschrift* situates three overarching concepts in Bill’s work within expanding literature on related topics: specifically to make integration the foundation of process-based best practices, to establish a theoretical framework for interdisciplinarity grounded in complexity, and to professionalize the field of IDS. It then examines two challenges to AIS that Newell (2013) identified in a reflection on the state of the field – transdisciplinarity and team science – followed by added insights from two areas – policy sciences and interprofessionalism. The article closes by reflecting on current conflicting priorities for the field today, renewed debate on the relationship of disciplinarity and interdisciplinarity, and efforts to explore intersections of multiple organizations vested in inter- and trans-disciplinarity today.

Integrating

In his contribution to the newsletter tribute, Nelson Bingham recounted Newell’s determination to provide a forum for interdisciplinary studies. The idea appealed to many but, Bingham stressed, there is “no doubt that the core

vision sprang from Bill's mind." In the late 1970s, he added, a growing number of professional organizations embodied interdisciplinary approaches with a topical focus, utilizing methods of various disciplines and theoretical models. Yet, AIS was the first to focus on the centrality of integration to IDS (Klein, 2016). In a 2013 reflection on the state of the field, Bill recalled the earliest article to present discussion in the organization. Newell and Green (1982) distinguished simply "drawing" on disciplines for insights from "integrating" them, foreshadowing emphasis on process in subsequent decades. The intent, he emphasized, was to distance AIS from those who claim to be doing interdisciplinary teaching without integration and whose courses reject disciplines rather than draw on them. The concept of integration has a long history. Two important shifts in educational theory during the 1930s prefigured the current process-based approach. The first moved from belief in unity of knowledge and culture, anchored in prescribed content, to process-based theory, grounded in learning how to synthesize different perspectives and to understand challenges of the contemporary world. "Integration" in the form of synthesizing accepted postulates was also distinguished from "integrative" building of new conceptual modes capable of producing a holistic experience (Klein, 2005; Boix Mansilla & Lenoir, 2010; Ciccorigo, 1970).

In a review of taxonomies of interdisciplinarity, Lisa Lattuca (2001) reported integration became the most common "litmus test." Pohl, van Kerkhoff, Hirsch Hadorn, and Bammer also called it "the core methodology underpinning the transdisciplinary research process" (2008, p. 411). Yet, debate continues on whether integration is the cornerstone of interdisciplinary research and education. Lattuca contended interdisciplinarity is as much about interaction of disciplines. In fields that prioritize critique of knowledge, she added, the priority may be "dismantling of disciplinary perspectives, not maintaining and integrating them" (2001, p. 15). Jill Vickers (1997) also criticized the premise of a unified epistemology. Some fields, such as environmental studies, are problem driven. Others are part of societal efforts for change, including the women's, Quebec, and First Nations' movements. Students most likely to resist borrowing respectfully from disciplines, she added, assert anti-disciplinary positions and draw on their own transdisciplinary theories, cultural traditions, and lived experiences. Looking back on 150 years of discussion, Clark and Wallace (2015) further charged the concept of integration is confusing because of competing lexicons, epistemological demands, and diverse viewpoints. There is no consensus on how to practice integration, they added, the literature is unorganized, and understanding is complicated by "a surplus of pseudo-integrative academic offer-

ings” (2015, pp. 239, 242).

Understanding is further complicated, O’Rourke, Crowley, and Gonnerman (2016) reported, by use of the concept in multiple literatures, including crossdisciplinarity, science of team science, philosophy, communication studies, management, and education. In a review of literature they identified multiple approaches to integration including unification by reduction, a global level of theory, an overarching abstract model such as general systems, alternative theories that can be integrated locally, interconnections between fields, and micro-level integrations. Variances also occur in *scale* (global versus local), *commensurability* (integratable inputs versus conflicts that require reduction before combining), and *comprehensiveness* (a broad compass versus focused outputs). O’Rourke, Crowley, and Gonnerman further identified four faultlines of definition. The first is algorithmic step models versus heuristic and constructivist frameworks. The second hinges on whether integration is cognitive in nature or also factors in social and communicative aspects. The third is integration as an individual versus a collaborative phenomenon. And, the fourth is emphasis on disciplines versus inclusion of societal perspectives. They classified Klein, Newell, Allen Repko, Gabriele Bammer (2013), and Bergmann, Jahn, Knobloch, Krohn, Pohl and Schramm (2010, 2012) as “integrationists” because they consider integration central to crossdisciplinary activity. Earlier Repko (2008, 2012) also contrasted integrationists with generalists such as Lattuca and Joe Moran (2002), who de-emphasized integration. Generalists treat interdisciplinarity loosely as any form of interaction or dialogue between two or more disciplines, while integrationists prioritize the concept and work toward a distinctive theory-based research process.

Newell and Repko followed Klein’s (1990) early model of how to do interdisciplinarity, emphasizing steps in leveraging cognitive insights. Newell, Repko, and later Repko and Szostak (2017) also emphasized individual and cognitive dimensions of integration. Like Newell and Repko, Veronica Boix Mansilla (2010, 2017) emphasized individual cognition but favored a neo-Piagetian “pragmatic constructionist” theory rather than a step model, arguing that meaning is adjusted in a dynamic socio-cultural context. Other theorists, including Bergmann and colleagues (2010, 2012), Bammer (2013), and Klein (2012, 2013) in later work are emphasizing the interrelationship of cognitive and social integration in collaborative research, as well as ongoing integration through iteration and recursivity.

Growing interest in process has also led to an increase in comparative studies of methods. Two works stand out. McDonald, Bammer, and Deane (2009) classified 14 dialogue methods for applied integrative research on

real-world problems, and Bergmann and colleagues (2010, 2012) compiled a primer of more than 40 methods for knowledge integration. In both cases, choice of methods depends on context. Growing emphasis on methods is not without dispute, however. Katri Huutoniemi (2014) criticized methodological foundationalism for imposing uniformity and predictability in order to ensure rigor and professionalism. In contrast, ecological thinking reformulates methods as heuristics, recognizing the role of rules of thumb, guidelines emanating from practice, and comparative weighing of possibilities in the context of a particular problem. Robert Frodeman (2014) also criticized emphasis on methods as a kind of uniform proceduralism that confers a “patina of objectivity” and he questioned whether there is any generalizable methodology, though he acknowledged the value of transferable skill sets and rules of thumb (p. 49).

Complexifying

In the widely cited report, the US-based National Research Council (2005) named the inherent complexity of society and nature as the first of four drivers of interdisciplinarity today, along with problems and questions not confined to one discipline, societal challenges, and the power of new technologies. The report linked complexity with a systems approach in major initiatives, such as the human genome project and cancer research. It also treated complexity as both an intellectual and an organizational challenge for managing interdisciplinary collaborative research. Even before that, complexity was aligned with interdisciplinarity. In 1972, Erich Jantsch called for a new approach to education and innovation capable of fostering judgment in “complex and dynamically changing situations” (p. 102). Over time, it became a widely cited reason for interdisciplinary practice in a widening range of contexts, from literary studies, physics, and biology to education, public policy, and environmental studies. Complexity is also deemed central to conceptualization of transdisciplinarity on both epistemological and pragmatic grounds. Founded in France in 1987, the International Center for Transdisciplinary Research is a forum for a new overarching scientific and cultural approach grounded in the worldview of complexity in science (http://cirtet-transdisciplinarity.org/index_en.php). And, launched in 2008, the Network for Transdisciplinary Research (td-net) focuses on complex real-world problems with the aim of developing strategies for research and policy (<http://www.akademien-schweiz.ch/en/index/Portrait/Kommissionen-AG/td-net.html>).

In 2001 the AIS journal became a locus for discussion when Newell

(2001a) proposed a theory of interdisciplinary studies grounded in the concept of complexity. The gist of his argument was that complexity is both a necessary and a sufficient condition for IDS. His theory was based on a connotation of complexity focused on the structure of a system, its components and relationships, and its overall pattern of behavior. Each discipline, he explained, focuses on one facet of reality but most real-world issues problems or issues are multifaceted. They incorporate multiple sets of variables that interact in non-linear ways. Interdisciplinary research entails integrating disciplinary insights in order to better identify and understand multifaceted phenomena of a complex system. Responding to the theory in the same issue, J. Linn Mackey (2001) contended Newell should have focused instead on chaos theory and nonlinear dynamics, though Newell distinguished his approach from explanations grounded in autopoiesis, chaos theory, nonlinear dynamics, and neo-evolutionary biology. Mackey (2001), Klein (2001), and Richard Carp (2001) also charged the theory reflected a modernist agenda that reifies disciplines and ignored extra-academic forms of knowledge, while Jack Meek (2001) called for testing theory in contexts of application. Replying to his respondents, Newell (2001b) acknowledged the danger of disciplinary hegemony but cautioned against questions of power overwhelming intellectual insights. Mindful that most people engaging in interdisciplinary process “are feeling their way,” and only a few are self-conscious about it, he also emphasized he proposed his theory in the hope it would foster increased self-consciousness and systematic critical thinking about interdisciplinary process (2001b, p. 147). The number of people who regard complex systems theory as the appropriate and legitimate focus for interdisciplinary studies, he added, will be far smaller than the number who find it to be a useful metaphor. One of the tests of theory is fruitfulness, and Newell’s theory has stimulated continuing discussion among members of AIS. A year later Rick Szostak (2002a, 2002b) and J. L. Mackey (2002) debated Szostak’s alternative twelve-step process for interdisciplinary research and the role of intuition rather than step-based models. Mackey even suggested the concept of emergence is appearing increasingly in discourse on interdisciplinarity to the point it might displace integration. More recently, Hirsch and Brosius (2013) presented a new alternative conceptual architecture of interdisciplinary collaboration that frames process in three ways of perceiving complexity within fields of conservation and development. The three integrative lenses are values and valuation, process and governance, and power and inequality. The framework is a structured guide for identifying and navigating trade-offs in negotiations among multiple actors, opening multiple pathways for research and practice. Each lens is accompanied by

sets of questions that can be used in context-sensitive flexibility rather than a singular or step model.

Professionalizing

Professionalization is a process by which a group establishes and maintains control of a social world. When higher education was restructured around the modern system of disciplinarity in the late 19th and early 20th centuries, new professional organizations formed to advance specialized subjects. Like the historical guilds that provided workers a community for their trades, these organizations met their members' needs while defining domains of expertise. The most prominent mechanisms of professionalizing in the academy are learned societies, conferences, publications, credentials and qualifications for advancement, methodological and theoretical tenets, and standards of practice. Professionalization is controversial. It enables members of a group to advance their interests. Yet, it also establishes boundaries of what is considered "inside" and "outside" a discipline or field proper. From the beginning of its history, interdisciplinarity has been claimed by multiple organizations. To name a few notable examples, in the early 1920s the term was shorthand for problem-focused research at Social Science Research Council (Frank, 1988). During the 1930s and 1940s it was associated with bridging history, literature, and culture in the new field and organization of American Studies. In the 1970s socio-political movements were catalysts for new groups focused on new fields such as black/women's/urban/and environmental studies. In 1970 the Organization for Economic Cooperation and Development played a leadership role in co-sponsoring the first international conference on interdisciplinarity. And, in the early 2000s, the National Research Council asserted authority for defining the concept.

Over time these and other initiatives created bibliographical footprints. Yet, Newell (2013) described the notion of a professional literature on IDS in 1979, when AIS was founded, as modest. Over time the Association built a body of publications though visibility was initially limited by lack of journal subscriptions in most academic libraries. Since then AIS members have contributed to a growing literature available to a wider audience. In his 2013 reflection he categorized AIS efforts as a three-stage progression from Pre-Theory (definition, images, and best practices) to Theory (modifications, application, testing, and his proposed theory), and Expanding Theory (enlarged conceptions of inter- and trans-disciplinarity). When AIS was founded, he recalled, the locus of activity in the US was education, mostly undergraduate liberal arts courses in humanities and social sciences. By the early 1990s

the typical conference presentation focused on implementing, not defining or theorizing, IDS. Yet, many reprints in the anthology Newell (1998) assembled as a defining professional literature were written by practitioners unaware of the existence of others. The question of whether there is a profession was also debatable, since many engaged in interdisciplinary study do not think of themselves as interdisciplinarians, identifying instead with their primary fields. Yet, by 1998, he declared the field of interdisciplinary studies had taken sufficient shape to be deemed a profession.

Since then, the number of undergraduate interdisciplinary courses has continued to grow. However, Newell (2013) reported, the primary locus of interdisciplinary activity and funding has shifted from teaching to research, from undergraduate to graduate level, from humanities and “soft” social sciences to natural sciences and medicine (and to a lesser extent “hard” social sciences), from an individual to a team activity, and from the ivory tower to the real world including participation of “non-academics” in research and problem solving. In light of these developments, he asked whether AIS should re-evaluate and expand its understanding of interdisciplinary process and theory, lest it risk irrelevance. At the same time, the Association of American Colleges and Universities (AACU) have advanced a broad definition of “integrative learning” that bridges high school and college, introductory and advanced levels, general education and majors, theory and practice, the classroom and the real world (Huber & Hutchings, 2004). Newell (2001c) described the nature of integrative and interdisciplinary studies as analogous. They both integrate insights from divergent perspectives and occur at multiple points in the curriculum with a synergistic “multiplicative power.” Yet, he emphasized, IDS is distinct in integrating insights solely from disciplines.

In his state-of-the-field reflection on theory, Newell (2013) highlighted two developments in particular – transdisciplinary studies and the science of team science. He suggested transdisciplinarity pushes AIS to rethink the premise that interdisciplinarity is reliant on disciplines, focused on understanding over application and implementation, located in the academy rather than the real world, and vested in intellectual inquiry instead of political and social activity. The science of team science also raises the question of whether interdisciplinary process should be recast as a team activity, in contrast to past AIS focus on individuals and commitments that differentiate interdisciplinary studies from team science. Expanding the current conception of interdisciplinary process to include transdisciplinary problem solving and team work, Newell admonished, might mean losing focus on “interdisciplin-

arity itself”: It might become difficult “to disentangle problems of teamwork from problems of interdisciplinarity,” and thus to avoid being “drawn into the messy world of interpersonal dynamics, motives other than discovering truth, and problems of communication and technology” (2013, pp. 36-37). Moreover, he wondered, “If we wish to expand and enlarge how far should we go?” He also faulted researchers in both areas for being “largely unaware of interdisciplinary process, let alone theory,” and in team science paying little if any attention to challenges of interdisciplinarity (2013, pp. 36-37). A more in-depth look at the two developments provides insight into how their interests diverge from and intersect with the interdisciplinary mission of AIS, with added insights from the fields of policy studies and interprofessionalism.

Expanding

The ascendancy of transdisciplinarity (TD) is a major development in the history of interdisciplinarity. Over time, definition has shifted from the historical quest for unity of knowledge to a plurality of synthetic paradigms with unifying capacity, including general systems, feminist theory, and sustainability. The word also became a label for approaches that transgress disciplinary boundaries while interrogating traditional canons of wholeness. The challenge TD represents for AIS emerged in German-speaking countries within environmental research during the late 1980s and early 1990s. It is grounded in real-world problem solving and co-production of knowledge with stakeholders in society. The Mode 2 theory of knowledge production has played a prominent role in this development. In contrast to disciplinary modes of research in Mode 1, Mode 2 is characterized by complexity, hybridity, nonlinearity, reflexivity, heterogeneity, and transdisciplinarity. It is expansive, generating new configurations and sites of research while moving beyond older notions of interdisciplinarity to foster synthetic reconfiguration and recontextualization of knowledge. Moreover, problems are not formulated in strictly academic terms. Multiple stakeholders bring heterogeneous skills and expertise and, as a result, organizational boundaries of control and competence blur (Gibbons, Limoges, Nowotny, Schwartzman, Scott, & Trow, 1994).

Science of Team Science (SciTS) is also positioned as a transdisciplinary initiative, described as a form of transcendent interdisciplinary research with the aim of creating new conceptual and methodological frameworks, theories, models, and applications. SciTS is building an empirical knowledge base to maximize efficiency and effectiveness of collaborative research,

propelled by the increased number and size of teams tackling complex scientific problems in science, engineering, and fields of health. It focuses on individual and organizational factors in a range of antecedent conditions and dynamics of teamwork, while moving beyond interdisciplinary bridging of disciplines to include professions, funding agencies, and science-policy bodies. Hence, management and leadership are primary concerns, along with the role institutional policies and practices play in fostering or impeding team science, including expectations for promotion and tenure. The aim is to achieve shared goals and objectives for greater productivity, linked with outcomes of new findings, methods, and translational applications of research. Moreover, integration is conceived as both cognitive and social in nature, rendering communication integral to the research process and redefining the concept of interdisciplinarity as teamwork (Fiore, 2008). Furthermore, in contrast to emphasis on education in IDS, training mechanisms and professional development are prominent sites of learning. (For a full account see the 2015 National Research Council report *Enhancing the Effectiveness of Team Science*.)

Policy studies and interprofessionalism are also sites of transdisciplinary development. In the inaugural issue of *Issues in Integrative Studies*, Raymond Miller (1982) cited policy sciences as an example of a transdisciplinary conceptual framework that transcends disciplinary worldviews. It is holistic in intent, and reorganizes the structure of knowledge. More recently, in the updated edition of *The Oxford Handbook of Interdisciplinarity*, Vogel, Cherney, and Lowham (2017) also defined the policy sciences tradition as a transdisciplinary approach for understanding and mapping action on complex real-world problems, and in the AIS journal, *Issues in Interdisciplinary Studies*, Wallace and Clark (2014) contemplated what policy sciences and interdisciplinary studies might offer each other. They evolved along similar intellectual paths and timelines but have not crossed paths often in literatures or practitioners' self-identities. Wallace and Clark described policy sciences as an intellectual toolbox for understanding and analyzing complex problems, elucidating goals of interdisciplinarity for civic and public processes of community and decision-making. Viewed as a configurative framework, they suggested, the field complements Newell's theory of IDS while prioritizing problem orientation and contextual mapping of social and decision processes.

The distinctive outlook of policy studies, Wallace and Clark elaborated, is a problem-oriented, contextual, and multi-methodological approach, not theory development or description. Thus it provides a procedural or methodological foundation for professional practice. The degree of inter- and

trans-disciplinarity varies. An interdisciplinary framework and propositions facilitate integrating disciplinary insights into a more holistic understanding, while transdisciplinary frameworks break free from disciplinary orthodoxies. The most prominent frameworks are problem orientation, social process, and decision process. Problem orientation is anchored in five tasks that allow logical exploration of aspects of a problem in a particular context: clarifying goals, describing trends, analyzing conditions, projecting developments, and inventing, evaluating, and selecting alternatives. A policy analyst moves back and forth between tasks so they mutually inform one another. Social process is a framework for clarifying sociopolitical contexts, in a set of conceptual categories that call attention to all elements potentially relevant within an environment.

Interprofessionalism is the second site of transdisciplinary development. Scott and Hofmeyer (2007) located the relationship of complexity and interdisciplinary research in recognition that renewal of the health system requires teamwork among physicians, nurses, therapists, social workers, and other caregivers. They called particular attention to cognitive dependence on social and spatial contexts that encourage interaction and integration, calling them enabling conditions for establishing common ground. Angus McMurtry (2011) has explored the relationship of interdisciplinary and interprofessional teamwork in greater detail. He called interprofessionalism a close relative of interdisciplinarity. Both are driven by multi-faceted societal problems, though interprofessionalism is more practical. Elsewhere, McMurtry (2013) also identified parallel features of integration in IDS and interprofessionalism, highlighting four discourses that move beyond traditional focus on individuals: communities of practice, cultural-historical activity, complexity science, and actor network theory. The conditions that nurture intelligent collectives include openness, flexibility, and negotiating conflict in order to arrive at synthesis.

McMurtry (2009) has also identified two perspectives on disciplinary knowledge and interdisciplinary integration. *Knowers* are conceived in terms of irreducible differences in an objective reality, and *phenomena* are explained in terms of sociocultural dynamics of disciplinary groups studying them. The two perspectives may be understood through the lens of complexity. Both interdisciplinary and interprofessional literatures contain attempts to explain disciplinary differences and interdisciplinary integration based on irreducibility or incommensurability of phenomena that are being studied, so are compatible with or explicitly invoke complexity science. Interdisciplinary theorists, however, have tended to neglect the influence of history, politics, economics, and other sociocultural factors on knowers. Literature

on interprofessional health care increasingly takes a phenomena-focused approach that reflects holistic and multileveled conceptions of health, viewing individuals in terms of multiple living systems ranging from cells and organs to social, cultural, and ecological collectives. McMurtry's call for an integrated understanding of knowers and phenomena has implications for transdisciplinarity, team science, and IDS, all of which contend complexity of problems requires a systems approach and, to reiterate, in the case of team science links cognitive and social integration. Organization, behavior, and communication matter as much as epistemology and ontology.

Prioritizing

The overriding question for interdisciplinarity today, Robert Frodeman (2017) wrote in introducing the new edition of *The Oxford Handbook*, is its place in the political economy of knowledge. Will it become central to transformation of the 21st century university? Or, are other vocabularies signaling displacement of the academy from the center of knowledge production, such as impact, accountability, and relevance? Funders today, Craig Calhoun (2017) noted in his chapter on interdisciplinarity in social sciences, bypass universities more often than their predecessors when seeking research from think tanks. In the first edition of the *Handbook*, Peter Weingart (2010) also contended the university has lost a monopoly on knowledge production and, as a result, quality in transdisciplinary research has become evaluated on not only disciplinary but also social, political, and economic grounds. Moreover, Steve Fuller (2017) reminded readers in the second edition, war and commerce have long been drivers of interdisciplinarity. They go against the established grain of academe in the name of use-inspired basic research. The triple helix model of state-industry-university relations was a key transition in the evolution of interdisciplinarity. Most theoretical discussions tended to treat it as internal to the academy, but the military-industrial context challenges the assumption academics have sovereignty over knowledge production.

Klein and Newell (1996) also recognized other motivations for interdisciplinary study beyond integrative education in their state-of-the-art report on "Advancing Interdisciplinary Studies," including professional training; social, economic, and technological problem-solving; social, political, and epistemological critique; faculty development; financial exigency; and production of new knowledge. The history of these motivations spans post-war expansion of interdisciplinary teamwork in space research, urban and environmental problem solving, and a renewed technology initiative

in science-based fields of economic competition that blurred boundaries of the academy, government, and industry, especially in manufacturing, computer sciences, biomedicine and pharmaceuticals, and high technology. By 2005, the NRC report on *Facilitating Interdisciplinary Research* cited government-university-industry collaborations as a major type of research. As transdisciplinary engagement of stakeholders in the research process took root, the keywords “participation” and “contextualization” also signaled a shift from solely reliable scientific knowledge to “socially robust knowledge” (Gibbons & Nowotny, 2000, p. 78).

In addition, critique loomed larger as more fields interrogated both disciplines and older forms of interdisciplinarity, signified in a new rhetoric of anti-, post- and trans- connotations of the core term. Multiple identities of interdisciplinary fields are also being recognized. Scholle (1995) called mass communication a boundary discipline situated between professional schools and liberal arts. It was constructed as a practical enterprise in schools of mass communications and speech departments. Yet, increased reliance on media and new digital technologies has heightened critical analysis of their impact. In mapping interdisciplinary studies, Giles Gunn also contrasted the conventional strategy of tracing relationships of existing disciplines, such as literature and psychology or philosophy with other approaches. New subjects and topics have emerged, such as the sociology of conventions and ideologies of gender, race, and class. Correlate disciplines have changed as well, challenging assumptions about the strength of boundaries. This degree of complexity seems to defy mapping. “The threading of disciplinary principles and procedures,” Gunn observed, “is frequently doubled, tripled, and quadrupled in ways that are not only mixed but, from a conventional disciplinary perspective, somewhat off center” (1992, pp. 248-249). They are not linear or traceable in all of their effects. They are characterized by overlapping, underlayered, interlaced, crosshatched affiliations, collations, and alliances that have ill-understood and unpredictable feedbacks. The nature of “genuine” interdisciplinarity, he argued, is ultimately a double-sided question, altering the constitutive question that generates interdisciplinary inquiry in the first place, asking how insights and methods of another field or structure can remodel understanding of a home domain, allied fields, and subject materials. Ethical criticism and American studies exemplify this aim in literary studies (1992, pp. 241-243).

The existence of multiple motivations has reinforced belief that the nature of interdisciplinarity varies from use to use. Respondents to Newell’s theory questioned whether any one theory could account for everything in a class of phenomena. Newell (2001a) acknowledged that claims interdis-

ciplinarity varies from use to use had been the subject of vigorous debates within AIS. Yet, he contended a theory grounded in complexity can bring together critique, problem solving, and integrative capacity under the single mantle of IDS. Still, Bailis (2001) pointed to other theoretical propositions including the work of Auguste Comte, Hubert Spencer, the Vienna Circle, the Social Science Research Council, Thomas Kuhn, Alfred Kuhn, and E. O. Wilson. Beyond that list appear the structuralist-based epistemological theory of Jean Piaget, Kenneth Burke's model of symbolic action, Mieke Bal's notion of travelling concepts, general social theory, Dogan and Pahre's theory of hybridization, Howard Gardner's multi-perspectivism, and Klein's boundary work.

Two metaphors also signal expansion of the older conception of interdisciplinarity to a transgressive connotation of transdisciplinarity – relationality and translation. The first image moves from linearity and unidirectionality to dialogue and circulation of ideas and resources. In defining the nature of learning in interprofessionalism, McMurtry argued that when individuals participate in a community of practice, akin to moving from apprenticeship to mastery, knowing and identity become situated in relationships. Actor network theory also locates learning and knowing beyond individual cognition, emerging in relations and interactions within networks. In sketching a new vision of architecture and urban planning, Tony Fry also proposed that transdisciplinarity is a form of relational thinking and redirective practice. It not only dissolves disciplinary differences, it constitutes a conceptual leap beyond pre-made methods, creating new ways of thinking and designing to grapple with complexity. It entails not only reflection on what has been done or why. It also considers the consequences of what practice brings into being and conditions of design. The process is not simply pragmatic. It is a rupture from a given practice that opens up the possibility of informed critical reflection. “Problems are never received,” Fry asserted, “but always interrogated and redefined. Likewise, practice never prefigures solutions – hereafter, architecture never just begets architecture” (2011, p. 21).

The metaphor of translation is associated with knowledge translation and translational research, characterized popularly in fields of health and medicine as transferring scientific knowledge from bench to bedside. Translation, though, is not a matter of rote transfer and application. Engebretsen, Sandset, and Ødemark (2017) described the stages of translation in the most common current model:

T1: from basic laboratory science to clinical research on populations;

T2: from clinical research to clinical studies resulting in develop-

ment of guidelines based on systematic reviews of clinical trials;
 T3: from clinical recommendations to routine clinical practice
 (and a proposed T4 extension to global health).

T1 and T2, Stephen Woolf (2008) explained, have different knowledge bases. T1 requires mastery of molecular biology, genetics, and other basic sciences, a prominent feature of interdisciplinary research today. T2 is situated in the context of community and ambulatory care settings, so requires the implementation science of interventions in real-world settings, adding expertise in areas such as clinical epidemiology, communication theory, behavioral science, public policy, finance, organizational theory, system redesign, and informatics.

The implications of relationality and translation for thinking about interdisciplinarity are profound. They signify a shift from thinking in terms of transferring and applying insights from disciplines to transactivity, emphasizing shared knowledge that emerges in the course of working together. Moreover, they are transgressive, subjecting all approaches to critique whether disciplinary, interdisciplinary, or professional. Transdisciplinary conception, Fry also contended, is post-disciplinary. It draws on but displaces fixed discourses. The goal is not to “bolt” disciplines but move from a given practice into contextualized and informed critical reflection continuing to learn what is required (Fry, 2011, p. 20). In the case of translation, Engebretsen, Sandset, and Ødemark (2017) explained, transfer of scientific knowledge into a practice setting is not simply rote application, any more than translation of a literary text from one language to another results in an exact copy of an original. A complex material, textual, and cultural process is involved. Knowledge translation has conventionally regarded social and cultural differences as barriers to transmitting scientific knowledge intact across various social fields and the healthcare system. Yet, they emphasize, this view is based on a simplistic understanding of translation and dissemination. The interplay between scientific and cultural factors can enhance the flow of knowledge through translational modifications and adaptation to new audiences, a relationship akin to Gibbons and Nowotny’s transdisciplinary concept of socially robust knowledge. The messy domain of practice, including clinician expertise and patient/user knowledge, is part of integrative process.

Debating and Bridging

Newell’s admonition to explore divergences and intersections takes on added importance at a time when the role of disciplines has become a matter

of renewed debate. Three recent works underscore the need for informed discussion about the relationship of disciplinarity and interdisciplinarity. In his book *In Defense of Disciplines*, Jerry Jacobs (2013) presented a case against interdisciplinarity. He countered criticism of disciplines as narrow silos by highlighting their dynamism and breadth, including communication across boundaries. Jacobs placed exchanges and diffusion of techniques, however, in the basement of the house of interdisciplinarity, below multi-, inter-, and trans-disciplinary synthesis. Yet, many proponents regard them as evidence of interdisciplinarity. He was also critical of interdisciplinary structures and topics that balkanize knowledge by creating more units and constraints rather than building a broad bridge between intellectual terrains. Jacobs rightly critiques the exaggerated positive valence of interdisciplinarity, but he assumes all proponents aim to overthrow the disciplinary system because disciplines are narrow and static, while failing to address real-world problems. This assumption ignores the work Newell and others have done on the complementarity of disciplines and IDS. Jacobs' strongest criticism is levied against administrative reforms that shift power and decision making from researchers and departments to deans and presidents, exacting centralized control. This phenomenon is especially strong in biomedical fields with sizable grant profiles. Jacobs would have administrators leave departments alone, confining interdisciplinary opportunities to centers or institutes while letting new appointments emanate within department structures.

Frickel, Albert, and Prainsack's (2016) collection of essays on theory and practice of interdisciplinary collaboration also addresses the relationship with disciplines. The editors frame the book as a response to three beliefs they contend underlie social scientific analysis of interdisciplinarity: (1) it is better than disciplinarity; (2) disciplines are silos constraining development of interdisciplinary knowledge; and (3) interdisciplinary interactions are not constrained by status hierarchies and power asymmetries within disciplines. Reviewing the volume for the AIS newsletter, *Integrative Pathways*, Szostak (2017) contended scholars associated with AIS as well as transdisciplinarity and implementation sciences would not assume #1 or #3, and in the case of #3 have spent a great deal of time identifying strategies for overcoming barriers. Moreover, they have taken a nuanced approach to #2, moving past dichotomizing to recognizing disciplines evolve and borrow from others. The editors recognize disciplines evolve, pointing to bibliometric evidence of cross-disciplinary citations. They also worry, rightly, that top-down interdisciplinarity driven by administrative prioritizing for grants can be not only problematic but not interdisciplinary. And, they recognize different meanings are employed within research groups for strategies favoring

particular disciplines. Szostak, though, responded by reinforcing the need for shared definition. It is also a mistake, he added, to compare disciplines and interdisciplines as the privileged ground for understanding the nature of interdisciplinarity. The last approach – interdisciplines – is the foundation of Harvey Graff’s (2015) *Undisciplining Knowledge*, which aims to reorient how interdisciplinarity is understood.

Reviewing the book for the AIS newsletter, Klein (2015) judged Graff’s claim overstated. The literature has already explored what he claimed is unique to his volume including historical and comparative case studies, institutional and organizational factors, the centrality of problems and questions, conflicting definitions and purposes, exaggerations and errors, and relationships among disciplines. Graff’s comparative case studies are illuminating, albeit uneven. His faulting of a name game is more problematic, however, charging the numerous typologies, classifications, and hierarchies of terms with generating more confusion than clarity, though he himself adopts a boundary between lack of integration in multidisciplinary and interdisciplinary practices. He also fails to acknowledge consensus definitions that have emerged and associates “so-called hyphenated” fields primarily with racial, ethnic, and gender studies, without accounting for scholarship on their interdisciplinary character. His familiarity with literatures on transdisciplinarity and convergence is limited as well. He charges a monolithic standard science-based narrative prevails. And, he situates scholarship on interdisciplinarity within a history “replete with sheer absurdity, wasteful competition, and hurtful personal invective.” Graff’s most astonishing claim involves AIS. Citing collections by Newell and Joseph Kockelmans, plus program descriptions and sample syllabi on the Association’s website, he asserts it is nothing more than “a miscellany of additive and multiplicative disciplinarity that cannot substitute for problems, questions, and intellectual relationships of knowledge, theory, method and practice” (2015, p. 64). Thus, Graff concludes, “AIS fosters diversity, multidisciplinary, and non-disciplinary, not interdisciplinarity” (p. 82).

Together the three books underscore the importance of Newell’s 2013 call for careful consideration of intersections that will only come from recognizing pertinent literature. Differences will not go away, but they need to be weighed in respectful dialogue. Viewed from a linguistic viewpoint, differing priorities are not surprising. Interdisciplinarity is an abstraction that has taken on meaning over time, leading to the current pluralistic and contextualist nature of the concept. Sometimes older connotations, such as unity of knowledge, become restricted or decline. As use of a term expands new connotations emerge and some are weighted differently over time, as in the

recent ascendancy of transdisciplinarity. The proliferation of terminology has led to belief that labels create more confusion than clarity, reflected in Graff's critique. Yet, patterns of consensus are an index of maturation in areas of interest, sharpening understanding of divergences and intersections that become a basis for dialogue across organizations. In contemplating how to bridge IDS and policy sciences, Clark and Wallace (2015) advised thinking in terms of a meaningful scale, building upon shared interests by using professionalizing mechanisms of journals and annual meetings in respective communities.

An attempt at formalizing dialogue was made in June of 2011, when key figures in inter- and trans-disciplinary organizations gathered in Utrecht, Netherlands to form INIT (an International Network of Interdisciplinarity and Transdisciplinarity). That effort, however, did not gain traction. A new attempt to bridge organizational resources began at the 2015 meeting of *td-net* in Basel, Switzerland. Moderated by Christian Pohl and Klein, an invited panel presented online resources developed in Canada, the US, Scotland, Switzerland, and Australia. Szostak represented AIS website links on *About Interdisciplinarity* and *Resources* (<http://www.units.muohio.edu/aisorg/>). Gabriele Bammer previewed the site for Integration and Implementation Sciences, with resources for improving complex real-world problem solving including tools, cases, and approaches along with information about pertinent journals, professional groups and networks, and conferences ([i2s.anu.edu.au](http://www.anu.edu.au)). Pohl presented the *td-net* website toolbox on "Co-producing Knowledge" (<http://www.transdisciplinarity.ch/>). Kara Hall demonstrated the US-based National Cancer Institute's Team Science Toolkit, a user-generated searchable repository of resources on team science featuring methods, measures, and an annotated bibliography (<http://www.teamsciencetoolkit.cancer.gov/public/home.aspx>). And, Catherine Lyall introduced the wiki-based "Short Guides to Interdisciplinarity" with digests of information on developing and reviewing research proposals, building and managing research teams, management challenges, leadership, evaluation, and funding (www.tinyurl.com/idwiki).

The Basel initiative continued at the 2017 *td-net* conference in Lüneburg, Germany when AIS ex-presidents Klein, Szostak, and Machiel Keestra hosted an AIS-sponsored session to discuss further ways of exploring intersections. That same year, the team science, and the digital humanities communities also explored intersections. Newell's 2013 reflection on theory of interdisciplinary studies, as understood within AIS, documents the importance of explicit attention to shared concepts in communities of practice. This kind of work entails not only his example of accounting for evolution

of thinking in an organization over time. It underscores the need to anchor understanding in the rigor of tested practices, not buzzwords. The most important lesson to emerge from Bill's call is the need for reciprocity, learning from each other to strengthen both shared concepts and imperatives as well as diverse contexts and agendas.

Biographical Note: JULIE THOMPSON KLEIN is Professor of Humanities Emerita in the English Department at Wayne State University. She has also been a Visiting Foreign Professor at Shimane University in Japan, a Fulbright professor in Nepal, Foundation Visitor at the University of Auckland in New Zealand, Mellon Fellow and Visiting Professor of Digital Humanities at the University of Michigan, and a Distinguished Women's Scholar at the University of Victoria. Holder of a PhD in English from the University of Oregon, Klein is past president of the Association for Interdisciplinary Studies and a recipient of the Kenneth Boulding Award for outstanding scholarship on interdisciplinarity. Her authored and co/edited books include *Interdisciplinarity* (1990), *Interdisciplinary Studies Today* (1994), *Crossing Boundaries* (1996), *Transdisciplinarity* (2001), *Interdisciplinary Education in K-12 and College* (2002), *Humanities, Culture, and Interdisciplinarity* (2005), *Creating Interdisciplinary Campus Cultures* (2010), and *Interdisciplining Digital Humanities* (2015). She was also Associate Editor of the *Oxford Handbook on Interdisciplinarity* (2010, 2017) and is co-editor of the University of Michigan Press series *Digital Humanities@digitalculturebooks*. She may be reached at ad5820@wayne.edu.

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