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Beyond Interdisciplinary Theory: Revisiting William H. Newell's Integrative Theory from a Critical Realist Perspective

by

Stuart Henry
School of Public Affairs
San Diego State University

Abstract: Accepting Newell's invitation to develop his interdisciplinary theory to address new developments, I first consider Newell's complex systems theory of interdisciplinarity. I then review developments of his theory before critiquing its merits and deficiencies. This critique is informed by recent critical realists' works that point to deficiencies rooted in interdisciplinary theory's holistic realist ontology, which they argue is incomplete. I then review critical realists' ontology and their case for interdisciplinary epistemology, which I argue marginalizes constructivism. Finally, I outline a constructivist-realist ontology. This approach incorporates an agentic theory of human agency and a social network view of social structure. I then consider the implications of this analysis for Newell's original ontology, and thus for his interdisciplinary epistemology.

Keywords: interdisciplinary theory, critical realism, ontological foundations, constructivist realism, agentic theory, actor-network theory, William H. Newell

Introduction

William H. Newell's theory of interdisciplinarity provides a method for conducting and teaching interdisciplinary studies. It has been described as a "stage and process model" (Holbrook, 2013, p. 1867) and the founding model of the "Interdisciplinary Methodists" (Frodeman, 2014, p. 43). But it is much more. It is a theory of method based on an ontology of reality as a complex system. Based on his ontology, Newell claims normative value for interdisciplinary inquiry relative to disciplinary inquiry when one is analyzing complex problems. Newell (2001a) does not dismiss the value of disciplinary inquiry but qualifies it. He states that if we assume reality exists in isolated parts or fragmented elements, then disciplinary inquiry is ap-

propriate. But once these elements are seen as interconnected and intermingled, as happens with "increasing connectivity, diversity, scale, and rapidity of change," then the resulting complex problems need an analytical frame beyond disciplinarity (Newell, 2007). It is this recognition by Newell of real-world changes demanding changes in our perception of reality (ontology) and our related epistemology that I am concerned with in this article. Thus, an appropriate starting point is Newell's (2001a) original theoretical statement.

Integrative Interdisciplinarity: Newell's Theory

In his 40 years of contributions to interdisciplinary studies, Newell was the first within the American Academy to establish an ontologically grounded theory of interdisciplinarity. With others[1] he moved the field toward a distinctive "integrative interdisciplinarity" (Repko, 2007) that some call the "synthesis model" (Barry, Born, & Weszkalnys, 2008, p. 28).[2] Robert Frodeman, ignoring Newell's ontology, claims his theory is a method not a theory and describes Newell as a "leading member" of the "Interdisciplinary Methodists" (Frodeman, 2014, p. 43). Critical realists have labeled Newell's theory "optimistic interdisciplinarity," as distinct from "pessimistic interdisciplinarity" or "pragmatic interdisciplinarity" (Bhaskar, Danermark, & Price, 2018, p. 17).[3]

Although having a longer history, by the late-1970s interdisciplinary studies focused on the "integration" of disciplinary insights into a holistic approach that became the hallmark of the Integrative School (Newell & Green, 1982; Klein, 1990; Newell, 2001a, 2001b, 2007, 2011, 2013; Repko, 2008; Repko, Newell, & Szostak, 2012; Szostak, 2002). The School defined interdisciplinarity as a process of integrating disciplinary insights into a more comprehensive perspective (Klein & Newell, 1997, pp. 393-394). Its purpose was to provide "a more effective basis for action than do the separate and more parochial understandings of the disciplines" because it offers a more comprehensive policy prescription to solve the problem under consideration (Newell, 2001a, p. 22).

Newell was very clear in articulating his ontological assumptions. These posit reality as a complex system and he provided interdisciplinarity as a res-

[1] Notably Julie Thompson Klein (1990).

[2] Newell does not talk about a "synthesis of disciplines" but a process of integrating disciplinary insights.

[3] However, Newell's integrative interdisciplinarity combines elements of both the optimistic and the pragmatic, being resonant with William James's and John Dewey's pragmatism, and having as its objective real-world problem solving. Moreover, Newell's ontological foundation is resonant with some critical realists' ontology and epistemology (Holland, 2014), which I will discuss later.

onant epistemology through which we can gain knowledge of that reality.[4] Others had long highlighted the problem of fragmentation of disciplinary knowledge and the need for knowledge integration or knowledge synthesis. Consequently, Stanley Bailis (2001, p. 29) raised questions about whether a new theory of integration was needed, whether interdisciplinarians wanted to follow such a theory, and whether, indeed, a single theory was a contradiction of the very idea of interdisciplinarity.

It is not that Newell was unaware of these early contenders for a theory of interdisciplinarity, but he saw them as ranging from "pre-disciplinary, not interdisciplinary" to illusory transcendent knowledge unifiers intended to erase disciplinary distinctions. Instead his interdisciplinary method grounded the energy of disciplinary tensions and "the internal contradictions within the complex realities it studies" (Newell, 2001b, p. 138). Newell saw deficiencies in the unifying vision of transdisciplinarity that others have since echoed (Graff, 2015, 2016).

Newell's interdisciplinary "theory" provides a "process, that both embraces and transcends the disciplines" (Newell, 2013, p. 31). It is a "theory" about the process of studying and explaining complex phenomena based on an ontology of reality as a complex system, best explained by a general complex systems approach. Given the wide variety of possible systems models, Newell needed to distinguish his vision of complex systems from other complicated systems (Newell, 2011).

Newell acknowledged, considered, and ultimately rejected a variety of different approaches to complex systems. He considered autopoietic systems, "a form of complexity where the overall pattern of behavior of a complex system is not only self-organizing, but self-generating and self-perpetuating." He claimed that some "behavior studied in the social and biological sciences is probably autopoietic" (Newell, 2001a, p. 12). He also considered but rejected chaos theory, neo-evolutionary biology, and quantum mechanics as being overly deterministic, despite their sophistication in analyzing iteratively reproduced patterned behavior. For Newell, chaos theory and neo-evolutionary biology fail to account for human reflexivity,[5] and quantum theory is too reductionist, despite it favoring non-linearity and emergent properties of relationships that are probabilistic and dynamic. Instead, Newell's preferred vision of complex systems has multiple "components/

[4] His various works (Newell 2001a, 2001b, 2007, 2011, 2013) describe the intellectual journey in which he grappled with comparable ideas and theoretical formulations to arrive at this position.

[5] This is an important component of his ontology that grants semi-autonomy to human agency rather than reducing agency to social structure or other causes.

elements/variables…linked/interconnected/interrelated (some strongly, others weakly), often organized in sub-systems." These components are linked both linearly and non-linearly, which produces an emergent behavior of the overall system that is subject to occasional periods of rapid transformation (Newell, 2013, pp. 31-32).

Newell's ontology distinguishes between "living complex systems" that "are self-organizing, self-correcting, and self-replicating," whose sub-systems are fundamentally interdependent, and "non-living complex systems" that "can merely inter-link their sub-systems" (Newell, 2001a, p. 10). He assumes that living human systems comprise individuals who have "bounded" free will making choices within a range of channeling and constraining social forces.[6] The resulting "reflexivity" can produce overall system change as humans reflect on the large-scale unintended consequences of their behavior and alter their behavior to change the systemic pattern. This insight introduces indeterminacy into the system by "creating new feedback loops, and even changing relationships that shape the overall behavior of the system" (Newell, 2001a, p. 11). This is a critical component in Newell's ontology for it shows that human reflexive agency can make a positive difference to an on-going and emergent overall system.

In Newell's ontological model the complex system is multifaceted, yet its facets must cohere for interdisciplinarity to be the appropriate analytical tool. System components are directly mutually co-producing and indirectly coproducing through positive or negative feedback loops. They are emergent through non-linear relationships. System identity emerges from the self-organizing interaction of positive and negative feedback and part-whole interaction, that are more than, and different from, the sum of its parts. Moreover, Newell sees the parts as sub-systems with their own dynamic emergent properties: "[T]ogether, the sub-systems and their nonlinear connections form a complex system." Thus, the more a "complex system links together combinations of components, simple systems, and even complicated systems using predominantly nonlinear connections," the more complex is the system (Newell, 2001a, p. 8).

The relational dynamics of a complex system are driven by flows of activity of varying strength through its non-linear relationships: "[T]he flow is not only more rapid in some parts of the system than in others, it accelerates at some points and decelerates at others" and it is this flow that produces patterns of behavior (Newell, 2001a, p. 9). The pattern of behavior in a complex

[6] Interestingly his bounded rational-choice model of human agents aligns with views of critical realists who attribute some degree of independent agency to humans (Archer, 2003, 2015).

system is "quasi stable"; it is "identifiable but evolving, intelligible but not strictly predictable...self-organizing...self-integrating or self-synthesizing" (Newell, 2001a, p. 9). Newell's ontological model of a complex system, therefore, incorporates unique behavior that is not system-determined but shaped by the system in which it is enmeshed. Thus "idiosyncratic behavior is responsive to the specific features of its location within a complex system...And if one is trying to understand the behavior of a specific place within a complex system, local knowledge matters" (Newell, 2001a, pp. 9-10).

Instead of examining the nature of the connections in a complex system that give rise to complex problems, Newell's ontology provides an underpinning for an interdisciplinary process of inquiry to study such problems. He acknowledges differences among interdisciplinary scholars about the nature of the process: "whether the process is linear and sequential, or looped and flexible." Indeed, his purpose is to produce a "solid theoretical basis" and provide a "theoretical rationale" for the steps that constitute the interdisciplinary process of inquiry (Newell, 2001a, p. 15). The object of Newell's theory is to develop "a procedure for testing the appropriateness of the steps that have come to be included in the interdisciplinary process." He believes that since the interdisciplinary process of inquiry is a "response to the nature of the reality being studied," it "should reflect what we know about the characteristics of complex systems." Therefore, "Each step in the interdisciplinary process should have some analog in complex systems theory" (Newell, 2001a, p. 16).

Newell draws several distinctions between disciplinary and interdisciplinary inquiry. Thus, instead of *defining a problem* at the partial sub-system level from the narrow framework of each discipline, the purpose of interdisciplinary inquiry is to focus broadly on the whole complex system, "redefining the problem accordingly" (Newell, 2001a, p. 16). Because disciplinarians' concepts and methods are developed at the sub-system-level, interdisciplinarians need to *determine* which disciplinary sub-system tools offer appropriate avenues into significant contributions. Even a cluster of disciplinary sub-system analyses cannot be relied on as inclusive of all that might be necessary because "the contributions of individual sub-systems to the behavioral pattern of the overall system may not be obvious," so interdisciplinarians need to be more inclusive and alert to "nonlinear connections that may have escaped attention" (Newell, 2001a, p. 17). In *gathering* concepts and contributions from disciplines to develop a holistic analysis of a problem interdisciplinarians "need not become experts in the disciplines they utilize" (p. 17). It is enough for them to gain a general overview and "sufficient command of [the] relevant portions [of each relevant discipline]

to illuminate the specific features of that particular complex system...so they can be alert to its other potential contributions to their study" (p. 17).

In *searching* for relevant disciplinary knowledge, interdisciplinarians may need to conduct new research, particularly into "nonlinear linkages between disciplinary sub-systems" that "fall outside the purview of every discipline" (p. 18). Indeed, the purpose of reviewing disciplinary contributions for *generating* interdisciplinary analysis "is to develop an understanding of how the behavioral pattern produced by the relevant portion of the sub-system it studies is related to its components and their relationships" (p. 18).

Newell's integrative interdisciplinarity involves integrating disciplinary insights "into a comprehensive understanding" (Newell, 2001a, p. 18), and probing disciplinary assumptions that have "demonstrated utility" in order to do so (p. 19). Interdisciplinarians need "to scrutinize and frequently modify terminology used by contributing disciplines" (p. 19), not least because similar concepts can have different meanings in different disciplines. Concepts "are defined by a discipline to bring out the characteristics of a component or relationship relevant to its sub-system" (p. 19). These change in the context of the entire complex system, such that "additional (perhaps even different) characteristics are likely to become relevant. After all, they are now seen as contributing to a different behavioral pattern" (p. 19).

Newell is clear that the object of interdisciplinary research is integration. This involves both deconstructing disciplinarians' concepts and theoretical relationships and reconstructing a new visualization of the phenomenon: "a complex system whose pattern of behavior is consistent with that of the phenomenon while it emerges from its constituent components, relationships, and sub-systems" (Newell, 2001a, p. 20). Integration, therefore, necessitates an iterative process of working backward from the phenomenon and forward from the sub-systems studied by different disciplines. Thus, the integrative process is non-linear involving first testing against one criterion, then the other, then revising and re-testing. The process is "driven by the tension between disciplinary insights and phenomenological pattern" (p. 20). Since interdisciplinarians know what the system's pattern should look like, Newell says they need "to understand why the behavior of the system exhibits that pattern, given the structure of the system and the behavioral patterns of its sub-systems" (p. 20).

As noted above, Newell knew that in the process of integrating disciplinary insights, the terminology and assumptions of the relevant disciplines need to be "adjusted" so they are responsive both to each disciplinary perspective on the patterns of sub-system behavior "and to the interdisciplinary understanding of the complex system as a whole" (Newell, 2001a, p. 20).

This involves creating "common ground" to identify sub-system linkages.[7]

Creating common ground involves four specific techniques (Newell, 2007). *Redefinition* releases disciplinary concepts and assumptions from the jargon-bound nature of their parent disciplines. *Extension* expands the meaning of disciplinary concepts and assumptions such that each can penetrate the domain of the other. *Organization* arranges the modified, expanded, or redefined insights along a continuum "to bring out a relationship among them" (Newell, 2007, p. 259). *Transformation* reconciles opposite concepts, again by organizing them into a continuous variable moving by degrees from one ideal type to the opposed ideal type. In summary, creating common ground involves replacing the either/or dualistic thinking of the disciplines "with both/and…inclusive thinking" (Newell, 2007, p. 260). The process creates a bridge between conflicting disciplinary concepts or insights, one that is "more like a context that surrounds conflicting insights than a vector between them" (Arvidson, 2015, p. 128; 2014).

In qualifying the extent of conceptual change involved in the common ground process, Newell tries to balance disciplines and the phenomenon under study, recognizing that all common-ground solutions are not equal and that the "best solution minimizes the change in disciplinary assumptions while still creating an adequate base on which to build a comprehensive understanding of the behavior pattern of the system" (Newell, 2001a, p. 21). He says, interdisciplinarians should "modify" disciplinary concepts, assumptions, and insights "as little as possible but just enough to enable commonalities" (Newell, 2007, p. 257). Once modified, disciplinary insights can be incorporated into "a more comprehensive understanding of the complex problem" (Newell, 2007, p. 257). "Successful integration produces a pattern that closely reflects the known behavior of the various sub-systems (and their components and relationships) as well as the behavior of the phenomenon under investigation" (Newell, 2001a, p. 21).

Newell says comprehensive solutions to problems derived from interdisciplinary research seek "an understanding of how the behavioral pattern of the system comes about from its constituent parts" (Newell, 2001a, p. 21). This is tested by the effectiveness of the comprehensive policy derived from the understanding to solve the problem: "Better integration produces more accurate or complete understanding and makes more effective action possible...An interdisciplinary understanding provides a more effective basis for action than do the separate and more parochial understandings of the disciplines" (Newell, 2001a, p. 22).

[7] The step of creating common ground is especially important considering subsequent criticism by critical realists discussed later.

It is important to note that Newell clearly sees the social system, its subsystems, and their linear and non-linear interrelations as objects of study and recognizes the importance of an epistemology that resonates with that reality. Important too, considering Dominic Holland's (2014) critique of "common ground" discussed later, is that Newell's method of creating common ground as a prelude to integrating insights explicitly seeks to preserve, not collapse conceptual differences, by enabling a dialog between opposites along a continuum.

Elaborations of the Epistemology of Interdisciplinary Integration

Since Newell's original theoretical statement (and others that followed it) there have been significant contributions by Newell's Association of Interdisciplinary Studies colleagues. Rick Szostak (2002) and Allen Repko (2008) develop a revised and improved epistemology of interdisciplinary integration as a process of stages.[8]

Szostak's (2002) "stage and process" model was built on Klein and Newell's work and incorporates comments from their critics with the aim of developing "a multiple-step guide to the performance of interdisciplinary research" that was more concrete and inclusive than the "steps" proffered by Newell (Szostak, 2002, p. 104). Szostak aimed not only to provide missing detail, but also to accommodate a diversity of interdisciplinary perspectives that Newell was accused of excluding. Szostak's objective was to identify a process that would subsume all the practical implications for doing interdisciplinarity into a multi-step process, clarifying how each step is distinct from steps in disciplinary research. The Table of Comparative Integrative Interdisciplinary Research Processes (see Appendix), however, shows that Szostak did not add anything substantially new, except for providing a way of comparing disciplines through his method of classifying their component parts (Szostak 2003, 2004; Szostak, Gnoli, & Lopez-Huertas, 2016).

Repko (2008; Repko & Szostak, 2017) provided perhaps the most elaborated of the post-Newell developments of integrative interdisciplinarity.[9] Repko outlined and clarified Newell's series of steps in the integrative process. As can be seen from the Table (see Appendix) this too was consistent with Newell, in all major aspects. As he presented them then, and has reiterated them since, Repko's first five steps require (1) defining the problem

[8] Subsequently all joined together in this task (Repko, Newell, & Szostak, 2012; Repko, Szostak, & Buchberger, 2013; Repko & Szostak, 2017), but notably made little change to Newell's original ontological foundation.

[9] Though see Newell's (2007) own elaborated version.

in terms of scope, complexity, clarity, and significance as appropriate for interdisciplinary study, and (2) establishing whether the level of complexity would benefit from the insights of more than one discipline. This leads to (3) identifying relevant disciplines and to (4) mapping both the problem, and the disciplines' key concepts, definitions, assumptions, and theories about the wider system relationships between the problem and other factors. This involves identifying previous related research findings and (5) developing an adequate understanding of the concepts, theories, and methods of the relevant disciplines.

In Repko's discussion of the integrative process, *Step 6* is critical but the least well defined. It calls for identifying disciplinary insights, without defining an "insight." Is it a hunch, a finding from a study, a reconceptualization of a problem or all these and other things? Assuming insights can be established, the process of integration involves identifying conflicts between insights and resolving them by creating common ground. This gets us to a highly controversial part of the integrative process, for it depends on whether resolving insights means developing a common language to accommodate opposing findings while maintaining their differential integrity or whether it means rewriting them to eliminate their differences. Repko only states that it means "using the common ground theory, concept, or assumption to integrate disciplinary insights" (2008, p. 295). Once resolved through the mechanism of common ground, these insights can be integrated "to produce an interdisciplinary understanding of the problem" (Repko, 2008, p. 295) that can be tested against the evidence.

As we shall see below, critical realists (e.g. Holland, 2014) have identified several problems with Repko's expansion of Newell's integrative interdisciplinarity, not least its failure to specify the ontological grounds for each stage in the process, even though these were specified by Newell's original statement.[10] They also believe that Repko is unclear on the integrity of levels of ontology and, therefore, confused about whether creating common ground transforms concepts in such a way as to dissolve important differences between elements.

Critical Responses to Newell's Integrative Theory

From the outset Newell's formalization of a theory of interdisciplinarity drew criticism from several colleagues (Bailis, 2001; Mackey, 2001; Carp,

[10] It is ironic that critical realists fail to recognize the link between the body of works of Newell, Szostak and Repko, but treat them as separate and independent, when, in fact, they all explicitly draw on Newell's original ontological foundation, and thus this body should be examined as an integrated theoretical whole.

2001; Klein, 2001). Most commented on the adequacy of Newell's epistemology: Do the "steps" in Newell's interdisciplinary process make sense as a process of inquiry? Bailis thought they were too general and unspecific and included vague "omnibus terms" such as "insights" and "assumptions." Moreover, the process assumes that researchers will know what disciplines are relevant in generating insights (Bailis 2001, pp. 35-36). Bailis asked "Why not focus more specifically on the elements of disciplines – their conceptions, their methodologies, their findings – that so plainly affect their claims?" (2001, p. 36).[11]

Among early critical appraisals of Newell's theory, that by Richard Carp offers an important social constructionist/postmodernist critique that questions the "hidden premise" (Carp, 2001, p. 78) in Newell's theory: that interdisciplinarity should be restricted to an integration of disciplinary knowledge and insight. Reflecting a transdisciplinary knowledge pluralism, Carp points out that disciplines are just one form of knowledge among many. He states that all "knowledge formations" – the term he prefers to "disciplines" – are "partial and situated," rather than being "a privileged site of especially valid knowing" (Carp, 2001, p. 71). Moreover, he questions whether disciplines constitute the very objects they claim to be describing: "What if disciplines and disciplinarity play a role in constituting the very objects they study?" (p. 78). Carp asks what forms of knowing should be included in an integrative process if those we currently include as "disciplines" are socially constructed, culturally and historically specific, and dynamically changing. He argues that we need to develop "integrative praxes that learn from multiple knowledge formations" and foster "ongoing conversation among these praxes" (p. 71).

Carp's article suggests we should "move away from thinking of the disciplines as unique sources or resources for knowledge and thought. We might instead imagine the disciplines as one sort of knowledge formation, of which there are several kinds…Any of these and other knowledges may be useful or even necessary...for example, the varieties of local, vernacular, or cross-cultural knowledge that are sometimes critical for success" (Carp, 2001, pp. 74-75). In re-conceiving of interdisciplinary studies, Carp argues for the notion of "learning from multiple knowledge formations" rather than restricting analysis/policy to those contained among disciplines in the academy (Carp, 2001, p. 75). Carp's suggestion invites us to be explicit about what kinds of knowledge we are integrating from multiple knowledge formations and whether, by selecting only some kinds of knowledge, we might be excluding other kinds. In short, we need a framework for knowledge pluralism, a "web of knowledge" that incorporates both marginalized academic knowl-

[11] Indeed, this is precisely what Szostak and Repko did.

edges and non-academic knowledges (Augsburg & Henry, 2016). Instead of relying on the integration of disciplinary knowledge Carp says "integrative praxes" may bring new objects and new knowing selves into being" to "generate new problematics, new questions, new objects, and new knowledges, some of which may challenge existing knowledges" (Carp, 2001, p. 93). He says integrative praxes may need to "listen carefully to learn from the excluded knowledge formations of the dispossessed – women, the poor, the internal colonies, the external colonies, webs of cultural trajectories outside Europe and the United States" (p. 93).

While Carp does not go in this direction, his suggestion could be formulated into a process that expands Newell's original model (see Appendix), but this would require a modified ontology. Before considering this, it is important to look at some of the more recent critiques of Newell's approach.

Recent Philosophical Critiques of Interdisciplinary Integration

Several philosophical critiques point to what they perceive as the epistemological failure of integrative interdisciplinarity. Robert Frodeman, for example, asserts that integrative interdisciplinarity is constrained from being genuinely critical because it is shaped by its socio-political location in the academy. As a result, "efforts to theorize interdisciplinarity have failed to judge interdisciplinarity on its own terms. Instead, interdisciplinarians have implicitly imported disciplinary standards and perspectives into their efforts" (Frodeman, 2014, p. 36). This is because interdisciplinarians are based in organized institutions of academia, which results in the disciplining of interdisciplinarity as an inevitable outcome of the need for academic survival in a world dominated by the institutional organization of academia. He says, "the point is as much political and economic in nature" (Frodeman, 2014, p. 36). This is because the whole academic system "is set up to pin our careers on the judgment of disciplinary peers" (p. 37).[12] Frodeman argues

[12] Interdisciplinarity is hampered because: individual disciplines occupy different departments of a university campus; degrees are conferred according to disciplines; funding has traditionally been skewed toward empiricist or monodisciplinary research; few publications are willing to publish interdisciplinary research, resulting in interdisciplinary authors being less cited; and their career advancement is more difficult (NAS, 2004, cited by Bhaskar et al., 2018, pp. 12-13). However, since the mid-2000s major U.S. funding agencies began to explicitly promote interdisciplinary research under the banner of "team science," leading to the recolonization of "interdisciplinarity" by disciplinarians (See Henry, 2005; Augsburg & Henry, 2009), and some universities such as Arizona State University have moved away from disciplinary departments toward interdisciplinary schools.

that because of increasing questions about the value, rigor, and results of interdisciplinary research "interdisciplinarians have sought all the other accoutrements of a discipline: a canonical set of readings; insider conferences, journals, and associations; degree programs and even freestanding departments" (p. 40).[13] In this context Frodeman sees Newell's work as driven to focus on "questions of method, technique, and codification."[14]

Britt Holbrook (2013, p. 1867) acknowledges that the distinguishing characteristic of interdisciplinarity is "integration" but questions whether interdisciplinarity need necessarily involve integration and consensus, which he sees as central to both Newell's and Repko's approach. In Newell's theory, integration *per se* is left relatively undefined but is premised on the creation of "common ground," a bridge between opposing disciplinary concepts, assumptions, and insights. Holbrook frames Newell's consensus integration in the tradition of Jürgen Habermas and Julie Thompson Klein where "interdisciplinary communication involves the integration of two or more disciplinary languages with the aim of generating a common understanding" (Holbrook, 2013, p. 1868). Holbrook says that such consensus integration aims at achieving "reciprocal comprehension, shared knowledge, and, in short, consensus between actors from different disciplines" (p. 1869). The result is a "stage and process model" for arriving at integration.[15]

Against the dominant integrative model of interdisciplinarity, Holbrook identifies two alternatives. One of these, based on the work of Thomas Kuhn and Alasdair Macintyre, calls for recognizing incommensurability between disciplines. Holbrook says this model sees interdisciplinary communication as only possible if one "learns the language of another discipline from within as a second-first language" (Holbrook, 2013, pp. 1868-69). A second alternative to interdisciplinary integration, based on the work of Georges Bataille and Jean-Francois Lyotard, calls for inventing a new language. Here incommensurability appears "when attempts at communication fail...

[13] This includes textbooks (Augsburg, 2007; Repko, 2008; Repko & Szostak 2017; Repko, Szostak & Buchberger, 2013).

[14] This echoes the debate raised by Newell et al. (2003) and summarized by James Welch (2007), between the Apollonian and Dionysian schools of interdisciplinarity. The Apollonian camp seeks conventional academic legitimacy through rigor comparable to "the methodologies of traditional disciplines" (Welch, 2003, p. 186), whereas the Dionysian interdisciplinarians stress more "open-mindedness and alternative ways of knowing the complex nature of reality" including the "less tangible faculties of insight" (Welch, 2007, p. 135).

[15] Importantly, Holbrook realizes that Klein (2005) is not in full agreement with consensus integration; she values the exchange around difference as well as around similarity. But from my reading so does Newell.

at which point…interdisciplinary communication is possible only through a process of inventing a new language" (p. 1869). Holbrook says the distinguishing characteristic of this version of integration is the invention of a new discourse, "one that is not merely an integration of the previously existing genres, but a novel co-creation of those who have risked and relinquished their previous disciplinary identities" (p. 1876). Under this model, distinctions between disciplinarities, multidisciplinarities, interdisciplinarity and transdisciplinarity break down and what becomes important is "whether we can proceed as if we all understand one another" (p. 1876).

Holbrook's "creation of a new genre of discourse" not only implies new knowledge but echoes some versions of transdisciplinarity. However, any emergent new language/knowledge depends on what is integrated.[16] The idea of integration across pluralistic knowledge formations (Carp, 2001) suggests that new object formations may become apparent and a new language may be created. Finally, the idea of proceeding so that "we can all get along" by relinquishing previous disciplinary identities naively ignores disciplinary hegemony and the power contained in disciplinary identities that critical transdisciplinarity seeks to deconstruct (Augsburg & Henry, 2016).

Ontological Foundations of a Critical Realist Interdisciplinary Epistemology

As noted earlier, Stan Bailis (2001) was one of the early critics to question whether Newell's version of complex systems theory was the best available. More recently, critical realists have criticized mainstream integrative interdisciplinarity for failing to adequately ground their claims of complexity on an ontological foundation. Thus, Holland argues that justifications for interdisciplinarity "are inadequate to the extent that they fail to elaborate on the nature of complexity and thereby leave interdisciplinary researchers without a clear understanding of what they are integrating" (Holland, 2014, p. 22).

In a series of works, Roy Bhaskar and his critical realist colleagues have challenged mainstream interdisciplinary integrationists for failing to establish ontology before developing their epistemology of interdisciplinarity

[16] And that observation leads to the distinction between the unifying transdisciplinarity of academic disciplines and transdisciplinarity that unifies disciplines with non-academic knowledge (see Nicolescu, 2008, 2010).

(Bhaskar, 2010; Bhaskar, et al., 2018; Price, 2014; Holland 2014).[17] For example, Bhaskar et al. (2018, p. 1) state "despite the extravagant lip service paid to interdisciplinarity, there is little sophisticated analysis in the literature that explains its philosophical necessity" and this relates to "an underlying lack of metatheoretical unity" (p. 9) or to a failure of interdisciplinarians to share a "common metatheoretical standpoint" (p. 12). Critical realists advocate integrating knowledge from disciplines, provided disciplines retain their integrity so that integration avoids "unilinear reductionism, additive atomism and naïve eclecticism" (Bhaskar et al., 2018, p. 1). This is because critical realists believe that specialized disciplines are best suited to address the differentiated tasks at different levels of reality, but they do not see this as inconsistent with achieving a process of transcendent interdisciplinarity (Bhaskar et al., 2018, pp. 1-2). Indeed, "we feel that each discipline uses methods that are specific to its subject matter and that acknowledging the usefulness of the different disciplines is not incommensurate with interdisciplinarity" (Bhaskar, et al., 2018, p. 13)[18] To understand critical realists' critique of mainstream interdisciplinarity's supposed lack of ontology it is important to examine their own ontological position.

Elements of Critical Realist Ontology: Toward a Foundation and Rationale for Interdisciplinarity

Critical realism has been recognized by many as a leading post-positivist foundation for social sciences. It claims to avoid the problems of interpretivism, social constructionism, and postmodernism, while at the same time its "reflexive philosophical stance" accommodates a wide range of perspectives (Archer et al., 2016). In the next three sections I will discuss critical realism's ontological foundation for interdisciplinarity and its critique of mainstream interdisciplinarity. In the remaining sections I go on to suggest that critical realism's polemic against interdisciplinarity and constructionism fails to do justice to the semi-autonomy of active human agency and its implications for social structure. Rather, I argue for an "agentic model" of human action

[17] It is important to reiterate that Newell as the founding mainstream integrative theorist went to great lengths to explicate the ontological foundation for his interdisciplinary method. Indeed, that Bailis (2001) could criticize Newell for selecting one version of ontology is indicative that he, indeed, had a developed ontology. However, as critical realism has turned toward critiquing mainstream interdisciplinarity, Newell gets little credit for laying out what is substantially a critical realist ontological foundation.

[18] Again, this is a point clearly acknowledged by Newell in his discussion of subsystems of the total system (Newell, 2007).

(Bandura, 2001) and a network-systems ontology of social structure leading to a "constructivist realism" (Cupchik, 2001; Newell, 2007).

Critical realism distinguishes between the reality of the world (ontology), referring to its object materiality, and our knowledge about it (epistemology), referring to our perception, imagination, and descriptive discourse. Thus, it rejects the postmodernist or interpretivist hermeneutically influenced account that reality is a social construction, arguing that while knowledge is socially constructed, "ontology must simply be understood as having a relative degree of autonomy from epistemology and interpretation" (Archer, et al., 2016). Critical realist ontology "asserts that much of reality exists and operates independently of our awareness or knowledge of it" and is "relatively autonomous" (Archer, et al., 2016).

In contrast to traditional Humean philosophy,[19] critical realism identifies two states of being: (1) the transitive state, meaning that state of reality which is subject to change because of human interpretation, and (2) the intransitive state of reality, which remains fixed and independent of humans. The "transitive" involves people and their beliefs, or scientists and their theories, which we might refer to as the interpretivist or constructionist frame of knowledge. This is complemented by the intransitive world that exists independently of people or interpretation. Rather than seeing the patterns, facts, events, and phenomena as its real entities, critical realism sees these as reflective of the underlying reality of the social world, as a "gateway to understand the complex, layered, and contingent processes or structures which cause those regularities, facts, and events" (Archer, et al., 2016).

The intransitive state may not all be directly experienced but we can experience the causal effects of intransitive reality through a variety of mechanisms that include discourse, numbers, non-verbal communication, and direct experience through human interactions, all of which depict aspects of the underlying reality. Even constructed realities can have real effects if we take them as representations of reality.[20] "It is therefore possible to be both an ontological realist, that is, one can believe that the real world exists...and an epistemological relativist, that is, one can believe that all knowledge is

[19] Humean philosophy reduced the state of being to our knowledge of "being," assuming we can only know the world through our studies and knowledge of it. Critical realism calls this assumption the "epistemic fallacy."

[20] This leads critical realists to identify three domains: the real, the actual and the empirical (Bhaskar, 1979). The real refers to objects or entities and their powers, causal mechanisms, levels and types. The actual refers to activation of the causal mechanisms through events, regardless of whether these have been experienced. The experience of these activated events constitutes the empirical, that which we study and measure.

socially produced and is transient, or fallible" (Bhaskar, et al., 2018, p. 28). It follows from this that although knowledge which is socially constructed will be replaced over time, we have objective grounds for differentiating some knowledge from other knowledge, one belief over another (Bhaskar, et al., 2018, p. 28; Archer et al., 2016).[21]

Critical realists thus make several foundational ontological assumptions about reality that they see as structured, differentiated, and changing (Bhaskar et al., 2018, p. 27). It is important to understand these assumptions to understand critical realists' later comments about the need for an interdisciplinarity epistemology. First, they distinguish between real structures, with their multiplicity of causal or generative mechanisms, and patterns of behavior and events that emerge from these structures. Second, they see reality as multi-layered, "laminated," and stratified (Collier, 1989; Parker, 2010). Third, critical realism claims stratification is "emergent." This means that one level of reality emerges from another level: "[T]he higher-order or emergent level is unilaterally dependent on the lower-order level...you have mind dependent on body, but you don't have body dependent on mind" (Bhaskar et al., 2018, pp. 30-31). Fourth critical realism claims "taxonomic irreducibility" such that "you can't understand the intentional behavior of human beings solely by reference to physical features...you cannot understand it by reference to properties of the lower-order levels" (Bhaskar et al., 2018, p. 31). Indeed, "the state of the higher-order level provides the causal efficaciousness conditions for the state of the lower-order level" (Bhaskar et al., 2018, p.31). In other words, once constituted, orders in a laminated system behave as their own objects, influencing other objects in the system and cannot be reduced to the parts whose interaction produced them.[22]

Critical realism accepts that there are differences, as well as similarities, when the object of inquiry is the social world. This means the ontology of the social world must be adjusted to deal with different subject matters to ar-

[21] Thus, critical realists claim ontological depth that other ontological positions undertheorize. These other positions commit the epistemic fallacy by reducing statements of deep ontology, of "being," to statements of knowing. Depth requires the recognition of rootedness in the real material world. Depth implies recognition of the existence of multiple layers of objects above the material elements, and their causal mechanisms are seen as part of a stratified, laminated system reflecting ontological complexity.

[22] For example, the properties of water cannot be reduced to the properties of hydrogen and oxygen. Similarly, the properties of legal institutions cannot be reduced to the properties of the human agents who created them (law-makers). Nor can the properties of laws be reduced to the human agents who apply them or who enforce them (police).

rive at a generalized social ontology of social science.[23] Thus, critical realists point to the importance for social science of the relationship between agency and social structure highlighted originally in the social theory of Anthony Giddens's (1979, 1984) structuration theory.

Human Agency, Social Structure and Critical Realism: Synthesizing Archer and Giddens

Structuration refers to the insight that human agents' actions are shaped and channeled by the social system of which they are a part, such that when acting through routine practices humans substantially reproduce the existing social system, as it reproduces them as social selves.[24] However, while society pre-exists present-day humans, it doesn't exist completely independently of their current activity whose everyday action can both reproduce and transform the pre-existing social whole. While human agents act within and make use of the medium that is the existing social system and its institutions, in the very process of acting they transform the totality, even if only marginally and even if unintentionally. Multiple human agents, acting similarly, but each marginally changing the totality can, over time, transform the totality in significant ways, perhaps with unintended consequences.

Recall that Newell's ontology presupposes humans as reflexive agents who can change the system in which they are enmeshed, and that, while he cautions not to exclude their rational capacity, he notes that this is not free rational choice but "bounded, limited, or constrained" by normative social factors (Newell, 2007, p. 259). Indeed, critical realist Margaret Archer (1982) criticized Giddens's (1979, 1984) original structuration theory for conflating agency and structure, and thus failing to recognize the independence of human agency. As a result, she says, Giddens is unable to examine how agency interacts with structure. Archer says that for Giddens, agents' "active creation of social conditions is itself unavoidably conditioned by

[23] Many of the differences between natural and social science reality can be informed by Alfred Schutz's (1967) distinction between first-order and second-order constructs. Schutz argued that the object world of natural science was subject to direct interpretation by scientists; he defined these as preconstructed constructs. The objects of the world do not themselves interpret the world. In contrast, social scientists' objects of inquiry are constructs that members of society have already created. Thus, social scientists are studying constructs of constructs or second-order constructs. This Schutzian differentiation provides the hermeneutical component to social science.

[24] Giddens's view posits a continuous duality between agency and structure, whereas critical realists see this as a continual dualism.

needing to draw upon structural factors in the process" (Archer 1982, p. 459). Archer says, in Giddens's view, the structural properties of the social system are "such that actors' inescapable use of them embroils everyone in the stable reproduction of social systems" (Archer, 1982, p. 460). However, Archer says that Giddens's claim that individual agents could have acted outside the system or differently contradicts that they are necessarily co-producing it.

In attempting to reconcile these positions on agency-structure relations Anthony King (2010) says, "Giddens seems committed to both a form of sociological determinism and to the assertion of individual agency at the same time" (King, 2010, p. 254). Giddens "wanted to explain how this vast institutional complex was reproduced by the individual, without reducing the agency of the human subject" (King, 2010, p. 255). King says that "For both Giddens and Archer, social structure, irreducible to the individual, was reproduced and changed by conditioned individual action" (King, 2010, p. 255).[25] Yet this seems to deny that their agency can also transform, not just reproduce, social structure.

For Archer "practice is the central means by which the self is created" (King, 2010, p. 256), where "the self emerges" as "someone with a sense of the self formed through our embodied relations with the natural world" (Archer, 2000, p. 152). She sees human agents' action as self-conscious, intentional, and reflexive and through their process of action they develop personal identity. This identity is "an emergent property of individual human action" (King, 2010, p. 257). For Archer, "personal identity – the product of an internal reflexive conversation – is independent of social circumstances, and it is vital to the transformation of society" (King, 2010, p. 257). Archer finally maintains that the individual is free. In Archer's later work as in the later Giddens (1995), individuals are not what they are but what they make of themselves. Individuals are able "to choose their own destiny through an internal conversation" (King, 2010, p. 257). King thus documents how both Giddens and Archer over time moved closer together, as Giddens focused more on human agency's capacity for "becoming" and Archer "moved from a structural orientation in the 1980s, to a preoccupation with reflexive individual agency in the late 1990s and early 2000s" (King, 2010, p. 256). Again, this aligns well with Newell's concept of reflexive bounded human agency, non-linear relations, and system change

[25] King sees a closer connection on the duality issue between Giddens and Archer and a range of other scholars including Habermas, Foucault and Bourdieu for whom "social reality is investigated as a duality of structure and agency" (King, 2010, p. 255).

in the process of its reproduction.

Critical Realism's Critique of Mainstream Integrative Interdisciplinarity

As stated earlier, critical realists falsely claim that mainstream interdisciplinarians fail to base their epistemology on an ontological foundation: "[T]here were no explanations as to what it is about the nature of the world that makes interdisciplinary work possible and indeed...necessary" (Bhaskar, et al., 2018, p. 44). This is despite Newell (2001a) doing exactly that. Dominic Holland (2014, p. 13) similarly states: "[W]hat advocates of interdisciplinary studies lack is a compelling rationale or justification for scientific integration, which is manifest in their failure to elaborate on the meaning of complexity." Yet revealingly, he admits Newell "goes some way towards deepening the ontological justification for interdisciplinarity," agreeing "that it is the complexity of reality that justifies interdisciplinarity" (p. 41). Holland goes on to recognize that "Newell works with a richer notion of complexity, a notion that draws explicitly on the insights of complexity theory, particularly the concept of nonlinearity" (p. 41). Holland further acknowledges that Newell's understanding of complexity, at least "in so far as it deals with the concepts of emergence and multiple causation, is clearly consistent with the philosophical ontology of transcendental realism" (p. 42). Ultimately, however, Holland states that Newell fails to sufficiently develop his ontological foundation for interdisciplinary studies: "Because Newell's ontological position is less explicitly defined he is unable to give a clear account of the precise ontological makeup of the complex systems" (p. 42). He says "Newell seems unsure about…the exact nature of the 'components' that comprise the system" (p. 42). However, Holland ultimately acknowledges Newell does, in fact, base his theory on an ontological foundation, albeit underdeveloped, from his point of view.

> Newell's theory of interdisciplinarity, then, in drawing on the insights of complexity theory and in pointing to the importance of emergent properties and multiple causation, *marks an important step forward towards a clearer ontological justification for scientific integration.* However, his conceptions of emergence and of conjunctural causation are underdeveloped from the perspective of transcendental realism, so that his conception of nonlinearity, which is fundamental to his theory, is rather confusing. It appears that vestiges of empiricism, in Newell's thinking, are blocking a full understanding of vertical and horizontal ontological depth, because a complete understanding of these two concepts would allow

> him to distinguish clearly between empirical variables and non-empirical system components. But, without such an understanding, Newell's theory remains vulnerable to criticism from those invoking the terminology of complexity theory. (Holland, 2014, p. 44, emphasis added)

Critical realists are even more unsympathetic to the work of Newell's followers and particularly his postmodernist critics. For example, Holland criticizes Repko's integrative interdisciplinarity for its emphasis on creating common ground, that was based on Newell (2001a; 2007). Holland says the concept of common ground dissolves the differences between conflicting disciplinary insights. He says, "the fundamental problem with Repko's theory of 'common ground' is that it appears unable to combine disciplinary insights in a way that preserves their differences" (Holland, 2014, p. 6). He sees the cause of this confusion as Repko's "failure to articulate a coherent ontology. Because he approaches the issue of integration at the level of methodology and epistemology, he fails to understand what features of reality can be integrated and how their differences can be preserved in an interdisciplinary understanding" (Holland, 2014, pp. 7-8). What seems to have evaded Holland is that Repko's epistemology is based on Newell's ontology, that Holland at least acknowledged as based on an ontology of system complexity.

Critical realists have also criticized Carp's constructionist critique of Newell's theory. For example, Holland states that Carp's (2001) postmodern response to Newell's theory "challenges the transcendental realist justification for integrative interdisciplinarity" (Holland, 2014, p. 44). The reason for this is that postmodernism challenges the critical realist assertion that knowledge reflects the existence of objects independently of the knower. Holland criticizes Carp's assumption "that reality is simply the product of ways of thinking and talking" (Holland, 2014, p. 45), and he criticizes Carp for his implication that we can integrate disparate knowledge formations, arguing that "If two or more knowledge formations have nothing in common, communication between members of each will be impossible and, if communication is impossible, how can we possibly integrate knowledge through 'integrative praxes'?" (Holland, 2014, p. 46). Holland offers no explanation about why it is that nonacademic knowledge formations would have nothing in common with each other, nor why they would have nothing in common with disciplinary formations, or for that matter why bridging concepts could not be built between non-academic and academic knowledge formations. Indeed, if each is subject to the underlying reality that critical realists "claim" this would suggest they would indeed have something in common. Holland

also argues that Carp's postmodernist concept of "integrative praxis" implies that there is an irreducible duality between theory and practice, which collapses the distinction between thought and being, and further implies that in Carp's approach "theory determines practice and practice determines theory" (Holland, 2014, p. 46). Holland concludes,

> The fundamental problem with the postmodernist conception of interdisciplinarity, therefore, is that it cannot sustain an intelligible conception of scientific integration and differentiation. If different forms of thought and language have no real basis – that is, they do not refer to objects existing independently of the observer – they can be sustained only through convention – the implication of which is that interdisciplinarity amounts to the deconstruction of existing disciplinary conventions and the reconstruction of new, interdisciplinary conventions. (Holland, 2014, p. 46)

Given critical realists' rejection of mainstream interdisciplinarity's claim for an ontological foundation, in the next section I examine the critical realist case for interdisciplinarity.

The Critical Realist Case for Interdisciplinarity

The ontological differences between natural and social structures, and the conception of a semi-autonomous dualism between human agency and social structure held by critical realists, mean that a different logic of discovery is needed for the social sciences. Ironically, echoing Newell's justification for interdisciplinary research methods, critical realists state that social scientists need a different epistemological model to deal with social structure's open systemic world, one characterized by a "multiplicity of causes" of an event. Critical realists, like Newell, argue that interdisciplinarity is necessary in social science research because open systems always involve a multiplicity of causes (Bhaskar et al., 2018, p. 45), which implies the existence of multiple mechanisms or structures. There are also internal relations between levels or elements of a system and a holistic causality between levels or elements. This means a change in one part of the system produces a change in all other parts of the system at all levels, but of varying weights of effect, and these changes can be both convergent and conflicting. This is because "causal mechanisms are of different types and act in conjunction, either reinforcing or counteracting each other's effects, and with differential force" (Holland, 2104, p. 7).

Epistemologically, say critical realists, this ontology "requires that we have a multiplicity of theories, each corresponding to the different mecha-

nisms or structures" (Bhaskar et al., 2018, p. 47). This further implies a multiplicity of disciplines because each discipline addresses different levels of reality, and each cannot be reduced to another. Further, "Any explanation will need reference to each level" (Bhaskar et al., 2018, p. 2). Similarly, for Holland "it is because the objects of scientific inquiry are all causal objects – their commonality – that they can be integrated (through their relations with each other), and…it is because their powers and liabilities have different effects that they can be differentiated and so studied separately" (Holland, 2014, p. 8). But multidisciplinarity is also necessary because of the phenomenon of "emergence" whereby one level of reality emerges from another and different disciplines address different levels of emergence. Moreover, because multidisciplinarity is limited by each discipline's isolation from other disciplines, *interdisciplinarity* is necessary to account for the emergent outcomes: "It is no longer possible to simply add up the results of the different disciplines. Scientists must do genuinely creative work between the disciplines. Interdisciplinarity is fundamentally implied by the prevalence of open systems and the emergence of levels and outcomes" (Bhaskar et al., 2018, p. 48).

Critical realists thus recognize the dialectical nature of this process such that "the mechanisms implicated in the open systemic phenomenon...may themselves be radically altered by the emergent synthesis or combination" (intradisciplinarity) (Bhaskar et al., 2018, p. 48). To arrive at a new understanding explaining how qualitatively new outcomes or new mechanisms emerge, critical realists believe scaffolding of new ideas requires interprofessional cooperation (which they call integrative pluralism) to enable understanding disciplines and fields outside one's own (crossdisciplinarity), to communicate effectively and thus produce a "transdisciplinary moment" (Bhaskar, et al., 2018, p. 49). This is not that different from Newell's original statement on interdisciplinarity in its attempt to arrive at a holistic understanding of complex problems; however, this resonance did not prevent Newell's integrative interdisciplinarity, and the ontology on which it was based, from either being overlooked (Bhaskar et al., 2018) or depicted as inadequate (Holland, 2014).

I argue that the critical realists' conception of the social world is based on an obsession with one version of ontology, and that this version commits the Durkheimian fallacy of "treating social facts as things," abandoning the duality of agency and structure. Critical realism is rooted in the physical world of science but fails to fully engage the constructionist and postmodernist critique that the social world is fundamentally different from the physical world. Moreover, while Bhaskar makes attempts to incorporate this differ-

ence, his conception of the social world is limited by the constant draw back to object reality, and by marginalizing constructivism to the realm of epistemology. He and his colleagues do not seem to see that, unlike the physical world, social reality is simultaneously constructed *and* objectively real; its objective *appearance* as independent of human agency is only possible by conceptually separating it from its ongoing social construction. Doing this commits the Durkheimian "reification fallacy" of freezing time, halting social construction, and stopping social production. Indeed, in the social world, it is not only possible for discourse to constitute interpretations of reality; it is also possible for representations to be constructed without there being an underlying reality, based on the representations alone; real social institutions can then be constructed to symbolically reinforce the constructed representation of the previously non-existent reality, but that doesn't make these more real. Crucially, because they are socially constructed, they are also subject to deconstruction and reconstruction in ways that the object world is not.

Critical realist supporters have seemed to bask in their own ontological dualism: They want realism with its insistence on an object world independent of the existence of humans, yet they claim to accept that the social world is not like the physical world. However, they ultimately prioritize the objective independence of the world over its socially constructed nature. They finesse this ambivalence by shifting the social constructionist quality of the social world to the epistemology of human agents of that world – to humans constructing knowledge of their world, rather than constructing the social world itself. Humans are the fallible components of the realists' analysis, not the objects that they construct; these are seen to exist independently of their producers (Potter & Lopez, 2001, p. 9).

Garry Potter and Jose Lopez (2001) illustrate the essence of this thinking. They argue that to make social life possible, social reality "must be ordered and structured" and there "must be some intransitive aspect of meaning for human life to take place. Further some measure of this intransitive dimension of meaning must be at least partially accessible to us" (p. 13). They argue that "meaning exists. It is there – an intransitive dimension of reality exactly as is molecular structure. It exists whether we understand it or not...meaning is communicable and possesses both a transitive and intransitive dimension" (p. 13). They accept that "Social structure is, of course, dependent upon human activity. Without that it would not exist" (p. 15). However, they also argue, as do other critical realists, that social structure has an independence. "As Durkheim argued, it pre-exists us. We are shaped and affected by social structures. Social forces act upon us. Social structures

limit our range of possible choices of action and thought...We do not 'create' social structure. We reproduce it and transform it. But it too causally affects us" (p. 15). So, the dualism here has us as both coproducing and transforming but does not suggest that these may be ever out of balance, such that it is sometimes more reproductive and other times more transformative, as in the Kuhnian model of paradigmatic science (Kuhn, 1970), or in Unger's (1976) dialectical social history of law, where periods of chaos and disorder are replaced by periods of order and "normalcy" before again returning to chaos and disorder, and so on over time. In the next section, I outline the views of constructivist realism and explore its implications for interdisciplinary epistemology.

Constructivist-Realist Ontology and the Epistemological Implications for Interdisciplinarity

So far, we have seen that the critical realist position presents an ontology based on a distinction between the physical world and the social world. Considering the social world, critical realism assumes that entities exist in layered strata. It further assumes these entities can act causally and independently to shape human action and human social identity as these human agents act back on that world from their own states of independence. We have seen that Newell's original complex systems theory embodied an ontology that is consistent with that proffered by critical realism. We have also seen that critical realists reject the social constructionist and postmodernist ontology that the social world is a product of the routine practices of discourse that make discursive distinctions and produce reorientations of reality.

However, suppose that instead of the dichotomy between realism and constructivism, we have a continuum, consistent with Gerald Cupchik's constructivist realism: Constructivist realism is "an alternative ontology that accommodates positivism and constructivism" and "acknowledges a social world…reflected in the natural attitude of daily life" that exists "prior to and independent of either positivist or constructivist analysis" and it accommodates social "processes which cut across the physical, social, and personal (self) worlds" such that each is "complementary and in parallel" (Cupchik, 2007, p. 1). Newell's continuum approach to scaling opposites is extremely helpful here.

Suppose that the objects of the physical world are the end of a continuum ranging from intransitive, independent of human construction, to marginally transitive, subject to some interpretation. Suppose that the objects of the

social world are at the other end of that continuum ranging from purely transitive and fully socially constructed to marginally intransitive, episodically resilient, and recurring. In other words, suppose our ontological assumptions for the social world were on a continuum of intransitive to transitive reality, and that rather than manifesting clear distinction, societies and social institutions moved toward different points on this continuum at different historical points in time. In this dynamic version of a "constructivist realist" ontology, Newell's system and sub-systems can accommodate a freedom of scale of coproduction and creative innovation as well as one that is significantly intransitive. This is also consistent with his notion of integrating incompatible or opposed concepts.

What arguments exist to support this ontological shift and how might that have an impact on an interdisciplinary epistemology? Moreover, would a change in ontology to recognize this sliding scale of reality impact epistemological assumptions about what constitutes knowledge of the social world? Does such an approach go beyond socially constituted disciplines? Would the emergent understandings enable the constitution of different conceptions of complex problems and different social responses to them?

Constructivist Realism: The Importance of Bandura's Agentic Perspective and Social Structure as Social Networks

In reconceiving social reality to accommodate both its transitive-constructive and its intransitive-objective qualities it is important to revise our ontological assumptions about both human agency and social structure. In this section I suggest that a model of human agency based on Albert Bandura's agentic perspective and a model of social structure based on Actor-Network Theory can provide the basis for a modified ontology for interdisciplinary epistemology.

According to Bandura (2001) humans act reflectively, purposefully, and in a self-regulating way, based partly on experience but also on the structural, social, or situational context, such that "human action, being socially situated, is the product of a dynamic interplay of personal and situational influences" (Bandura, 2001, p. 154). Humans interpret the world as they perceive it, but they also act on the world they experience rather than just reacting to it: "People are agentic operators in their life course, not just on-looking hosts of internal mechanisms orchestrated by environmental events" (p. 155). Rather than simply being subject to regulation and control by others, people are self-regulators of their own motivation and to varying degrees shape and determine the activities they pursue: "Persons are neither autono-

mous agents, nor simply mechanical conveyers of animating environmental influences" (p. 156), but they develop because of the interactions that they have with their social experiences and observations. Cognitive, emotional, and biological factors interact with "behavioral patterns," "environmental events," and social contexts "to influence each other, such that changes in one result in changes in the other" (pp. 156-157).

This dialectical agentic approach to human behavior recognizes not only that humans and social contexts affect each other, but also that the behavior they produce can influence the persons in the interaction, their social situations, and ultimately the wider social structure. Thus, people's "behavior plays a dominant role in how they influence situations which, in turn, affects their thoughts, emotional reactions and behavior" (Bandura, 2001, p. 157). In short, behavior is "an interacting determinant rather than a detached by-product" (p. 157) of social interaction with others and one's social and situational environment. People "function as contributors to their own motivation, behavior, and development within a network of reciprocally interacting influences" (p. 169).

Consistent with Newell's constructivist-realist perspective, humans think about likely courses of action and select or discard them before enacting them. In their behavioral choices people are not only guided by social expectations and constraints but also have the capacity for self-direction and, importantly, for self-regulation (Bandura, 2001, p. 175). People are selectively attentive in monitoring aspects of their own behavior. Whether and how they act will depend on how they judge their intended action against personal guidelines and standards, related to the behavior of others, to social norms, values and to their sense of personal adequacy. Bandura's agentic view of human behavior has major implications for how humans relate to social structures in which they are enmeshed and though which they act.

Another important challenge to the critical realist ontology has been developed by social network theorists. Instead of accepting that social reality is constituted by object-like entities such as structures and institutions, they argue that the social world is comprised of social networks of interactive relations. Hubert Buch-Hansen (2014), while finding some resonance between social network theory's ontology and that of critical realism, argues that few scholars have integrated these perspectives.

> [Social network analysis] understands networks as sets of objects called "nodes" that are connected by one or more relationships called "ties"…nodes can be a wide range of social units, such as individuals, groups, organizations, companies, governments, and countries. Likewise, a large variety of rela-

> tionships can be studied, relating, for instance, to club membership, family, information flows, ownership, competition, and employment. (Buch-Hansen, 2014, p. 308)
>
> SNA scholars use notions such as "cliques," "clusters," "blocks," and "bridges," to divide actors in networks into subgroups based on the patterns of their relations with one another. (Buch-Hansen, 2014, p. 309)

An important aspect of the depth ontology of social network theory is that reality consists of interactive networks of relationships, not separate entities, and this is because social relationships are relationally connected to other social forms, such that when one set of relationships change the other sets also change. Social structures are understood as "networks of networks" where networks act both to constrain and enable human agency. This implies that human agents can be changed by network relationships but can also make changes to these networks. The concept of "emergence" in social network theory means "that social ties can bind nodes together in such a way as to construct a new entity whose properties can be different from those of its constituent elements" (Borgatti, Mehra, Brass, & Labianca, 2009, p. 894).

King (2014), who leans toward the more post-structuralist actor-network theory, draws out some similar but some different implications that the social network approach has for critical realists.[26] He states this approach is most visible in the works of Latour (2005) that recognize the actor's network engagement both with the real world of objects and the social world of constructions. "Relationality" is a key concept in this thinking that sees entities in a network whose properties and boundaries are constituted through their relations with other actors and entities in the network. Here social networks are open and indeterminate social webs transcending social institutions and social structures. These networks have emergent properties as Archer and Newell have described. They are irreducible to their component individuals and must be understood as open-ended totalities. King argues that the individual agent does not confront an already completed network. Rather, agents act collectively as joint participants in the network, mutually constituting themselves through their recurrent interactions (King, 2010, p. 258). King says in this view, Latour (2005), for example, sees social reality comprised of "dynamic and often quite contingent 'assemblages' of very wide social networks" (King, 2010, p. 258). Indeed, he says that the implication of a network analysis is that social reality "is influenced by all these agents and consequently, they are all ultimately involved in the production

[26] For a comparison of the similarities and differences between actor-network theory and social network theory see Vicsek, Király, and Kónya (2016).

of science" (King, 2010, p. 258). Similarly, King points to Collins's (2004) theory of "interaction ritual chains" and King claims that "innovation arises not out of individual genius but is collectively created in dense intellectual clusters, themselves located in networks spanning time and space" (King, 2010, p. 258).

Once we move beyond agency and structure as separate object entities, toward the notion of mutually constituting relations between active agents and the social structures they reproduce and transform, we arrive at "demonstrating how distinctive forms of collective agency arise in particular milieus" (King, 2010, p. 259). Thus, King says we may need a "'network-centric' ontology" (p. 259). Here it is necessary to understand social reality "not in terms of an individual confronting a pre-formed structure but in terms of multiple participants negotiating as they interact with and co-operate or struggle with each other" (p. 259).

A network-centric ontology utilizing an agentic view of humans has major implications for the epistemology of interdisciplinarity as it suggests that knowledge is constituted through multiple different networks producing their own knowledge formations as Carp argued. One network may be organized academic disciplines in research settings engaged in knowledge production, that are both reporting on and shaping the world of research and, to some extent, its perceived reality. Other knowledge formations may emerge from networks unconnected or marginally connected to academia, such as mutual aid and self-help groups whose members may co-constitute an alternative reality and a set of complex problems alternative to those offered by existing networks of academic scientists. Thus, we would need an interdisciplinary process that reflects this changed ontology.

Newell's theory of interdisciplinarity with its relatively undefined open system of sub-systems and linear and non-linear relations, seems very compatible with this vision of ontology and implied epistemology. Indeed, at the end of Newell's (2013) "State of the Field" assessment of his own interdisciplinary theory, he invited just such a transformation. He said

> 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...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. (Newell, 2013, pp. 35-36)

So, if we posit a network-centric ontology that takes an agentic view of human agency operating within an actor-network vision of social reality, what might the interdisciplinary research process look like? By illustration we can draw on Carp's (2001) vision of knowledge pluralism here, one that recognized the significance of transdisciplinarity as in the integration of disciplinary and non-disciplinary knowledge. Based on these modifications to our ontological assumptions we can formulate a revised version of Newell's theory of integrative interdisciplinarity as indicated in the Table of Comparative Integrative Interdisciplinary Research Methods (see Appendix).

Conclusion

In conclusion, Newell's theory of interdisciplinary studies, most fully articulated in 2001 in this journal, deserves recognition as ontologically foundational, both preceding, and transcending, recent critical realists' forays justifying and making claims to be the first ontologically grounded interdisciplinarity. Newell's embodied constructivist-realist ontology, conceiving of reality as a complex open system comprised of linear and nonlinear relations that are simultaneously objectively real and socially constructed was way ahead of its time. Its constructivist-realist ontology transcends critical realists' magnetic attraction to objectivist ontology, with its compartmentalization of constructivism to the realm of epistemology. Newell's ontology is sufficiently accommodating to incorporate a realist vision of linear and non-linear relations between complex systems and sub-systems, as well as a dynamic social network conception embodying a continuum of transitive and intransitive social objects, driven by interacting human agents actively engaged in the social construction of networks and networks of networks. His continuum approach, reflected in his epistemology for integrating incompatible disciplinary insights, leads to a modified version of interdisciplinary epistemology, and to a wider holistic approach to complex problem solving. The Newellian theory of interdisciplinarity is ripe for liberation from its focus on academic disciplinary knowledge, to embrace a variety of multiple knowledge formations, not least because its revised constructivist ontology recognizes that all human agents are involved in social network constructions of reality. To return to the spirit of "enriching Newell's theory" (Holland, 2014, p. 44), I would suggest going back to Newell's foundational ontology and re-considering its embodied ontological integration of realism and constructivism. Doing so will produce a richer, more complete ontology

on which to ground a comprehensive interdisciplinary epistemology.

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Biographical Note*:* Stuart Henry, PhD is a professor in the School of Public Affairs at San Diego State University where he was previously School Director (2006-2017). Prior to that Dr. Henry was Director of Interdisciplinary Studies at Wayne State University (Detroit; 1999-2006) and before that was Professor of Criminology at Eastern Michigan University (1987-1999). He has also served as Chair of Sociology at Valparaiso University (Indiana), Director of Interdisciplinary Studies at the University of Texas at Arlington (2010-2011) and was most recently a Visiting Scholar in the Department of Sociology, University of Hawai'i Mānoa (2017). His publications include 34 authored/edited books and over 100 articles in journals or book chapters. He is currently working on a new book manuscript entitled *The Politics of Transdisciplinarity*. He is the former Editor of *The Western Criminology Review* (2011-2014), former co-Director of The Center for Ethics in Science and Technology (2007-2010), and has served on the Board of the Association for Interdisciplinary Studies and The Western Society of Criminology. He may be reached at stuart.henry2@gmail.com

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Appendix: Comparative Integrative Interdisciplinary Research Process

Newell (2001)	Szostak (2002)	Repko (2008)	Adapted from Carp (2001) by Henry
		2. Justify using an interdisciplinary approach.	1. Explain why the topic or phenomenon under study is complex, and identify how it is impacted by multiple networks and needs a transdisciplinary approach.
1.Define the problem (question, topic, issue).	1. Start with an interdisciplinary question.	1. Define the problem or state the research question.	2. Define the problem from the perspective of different knowledge domains as these are shaped by the networks of relations that impact and are impacted by the problem.
	2. Identify the key phenomena involved, but also subsidiary phenomena.		

	4. Perform a detailed literature survey. The goal is to identify the theories, methods, and phenomena encompassed by previous research, and the results of that research.	4. Conduct the literature search.	3. Conduct multi-media research of both academic and non-academic sources and ensure to include marginal theories and perspectives, critical perspectives and micro-meso- and macro-levels of analysis, as well as knowledge of network actors at different locations in the relevant networks.
2. Determine the relevant disciplines (including interdisciplines and schools of thought).	5. Identify relevant disciplines and disciplinary perspectives, which includes gaining a grasp of the discipline and an understanding of relevant subdisciplines.	3. Identify relevant disciplines.	4. Determine the relevant knowledge domains including academic disciplines, sub-disciplines, interdisciplines and transdisciplines, professional knowledge and non-academic knowledge formations, (including stakeholders of problem solvers and problem sufferers who are part of the networks) where relevancy is determined by location at or in relationship to nodal points within the networks.

3. Develop a working command of the relevant concepts, theories, and methods of each discipline.	3. Ascertain what theories and methods are particularly relevant to the question at hand. Consult a typology of theory types, considering those related to different phenomena: describe group processes, individual actions, relationships. Similarly consider different methods.	5. Develop adequacy in each relevant discipline.	5. Develop a working command of the relevant concepts, theories, and methods of each knowledge domain, and network, regardless of how formal or informal these networks are or how sophisticated their modalities of communication.
	6. If some relevant phenomena (or links among these), theories, or methods identified in (2) and (3) have received little or no attention in the literature, the researcher should try to perform or encourage the performance of such research, studying links ignored by disciplines, particularly non-linear links.		

4. Gather all relevant disciplinary knowledge.	7. Evaluate the results of previous research. Place disciplinary theory, method and research in a broader context. Question whether non-scholarly analysis provides further perspectives. If so, non-scholarly research should be evaluated as well.		6. Gather all relevant knowledge into a matrix of knowledge, from formal, organized academic to informal unorganized and spontaneous knowledge generated in and flowing through relevant networks.
5. Study the problem from the perspective of each discipline.			7. Study the problem from the perspective of each knowledge domain and from various network positions.
6. Generate disciplinary insights into the problem.		6. Analyze the problem and evaluate each insight or theory.	8. Generate insights into the problem that include concepts, interpretations, framings, methods, network connections, policy implications, research findings and experiential explorations.

7. Identify conflicts in insights by using disciplines to illuminate each other's assumptions, or by looking for different concepts with common meanings or concepts with different meanings, through which those insights are expressed.		7. Identify conflicts between insights or theories and their sources.	9. Identify conflicts in insights by looking for different concepts with common meanings and concepts with different meanings through which those insights are expressed and generate general concepts to incorporate the range. of insights that converge and conflict from the different knowledge domains inside and outside of the relevant networks.
8. Evaluate assumptions and concepts in the context of a specific problem.			
9. Resolve conflicts by working toward a common vocabulary and set of assumptions.	8. Compare and contrast results from previous disciplinary or interdisciplinary research (communities of scholars) toward a consensus on terminology and translation into a common vocabulary.		10. Incorporate conflicts into a new inclusive vocabulary and set of assumptions that retains the dialectic of differences while mapping similarities.
10. Create common ground.		8. Create common ground between concepts and theories.	11. Create a dialog around differences.

11. Identify (non-linear) linkages between variables studied by different disciplines.			12. Identify intersections and relationships between different points in the networks as reported from different knowledge domains.
12. Construct a new understanding of the problem.	9. Develop a more comprehensive/integrative analysis. Ascertain which types of integration are most important for particular questions; a complex combination of theories, each shedding light on different (possibly overlapping) pieces of the puzzle is more realistic than a unified theory; the range of applicability of each should be specified, as should the strengths and weaknesses of different methods. Attempt to understand how multiple causation and feedback loops interact between different pairs of phenomenon, including non-linear links.	9. Construct a more comprehensive understanding.	13. Construct a new composite understanding of the problem that takes account of the convergent and divergent positions within and peripheral to the relevant networks.

	10. Reflect on the results of integration. Reflect on interdisciplinary biases, weaknesses in theories and methods contained in integrative synthesis, and its results and implications.		
13. Produce a model (metaphor, theme) that captures the new understanding.			
14. Test the understanding by attempting to solve the problem.	11.Test the results of integration through empirical testing on real world problems.	10. Reflect on, test, and communicate the understanding.	14. Evaluate the new understanding by attempting to solve the problem via mobilizing key aspects in the network relations.
	12.Communicate the results. Try to speak both to an interdisciplinary audience and to relevant disciplinary audiences.		15. Communicate the results back to the knowledge producers for deliberation and modification, incorporation and transformation.