COMPLEXITY AND INTERDISCIPLINARITY

W. H. Newell
School of Interdisciplinary Studies, Miami University, Oxford, Ohio USA

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"The only way in which a human being can make some approach to knowing the whole of a subject is by hearing what can be said about it by persons of every variety of opinion and studying all modes in which it can be looked at by every character of mind. No wise man ever acquired his wisdom in any mode but this." John Stuart Mill.

Summary

Together, theories of complexity and interdisciplinarity offer a way of thinking about our world that creates meaning and order while embracing fragmentation and recognizing the very real disorder all around us. The dichotomies of holism and fragmentation, order and disorder, can be replaced by complex systems that reveal hidden (albeit partial) order in apparent randomness, and by interdisciplinary study that integrates fragmented insights from reductionist disciplines into holistic understanding. More pragmatically, interdisciplinary study of complex problems has the potential to identify solutions that are manageable (because they are built on recognizable patterns of behavior) while they are realistic (because they take into account the complex nature of each problem).

The seemingly intractable nature of the major societal and environmental problems we confront may reflect the partial nature and simplistic assumptions of the individual disciplines that have been brought to bear on them so far. Through policy informed by interdisciplinary study of these complex phenomena, we may be able to address the problems confronting our life support systems.

1. Introduction—Holism and Fragmentation, Order and Disorder

Both complexity and interdisciplinarity need to be understood in the context of long-term trends toward the fragmentation of knowledge and the unraveling of simple order in our world.

The exponential growth of information over the last half-millennium has been driven by, and in turn reinforced, a divide-and-conquer approach to the production, distribution, and application of knowledge. After all, Leibniz (who died in 1716) was said to be the last person to know everything there is to know. The philosophical base for this approach was *reductionism*—the strategy of dividing a phenomenon into its constituent parts and studying them separately in the expectation that knowledge produced by narrow specialists can be readily combined into an understanding of the phenomenon as a whole. The organizational result was the development of over twenty new academic disciplines around the beginning of the twentieth century and the fragmentation of the disciplines themselves into a host of sub-fields in the last half of the twentieth century. Renaissance dreams of the unity of knowledge have faded with the very success of rational inquiry.

While the motivation underlying our search for knowledge is essentially to bring order and create meaning out of the welter of sensory inputs we receive from the world around us, its ironic by-product has been to undermine that very order. Copernicus' heliocentric model of the solar system, Darwin's theory of evolution, Freud's theory of the unconscious, Gödel's incompleteness theorem, Arrow's impossibility theorem, and the entire field of quantum mechanics are only a few notable examples of advances in knowledge that have progressively undercut our notions of the simple order of our world. The apparent promise of Newton's mechanics—that a few, simple, ultimately knowable principles underlie the fundamental order of our world—has increasingly proven false. While many scientists still cling to the presumption that disorder masks undiscovered simple principles or reflects errors in measurement, a growing body of scientific evidence suggests that simple order may be illusory as well as elusive. We have been forced to rethink the very notions of order and disorder.

The twentieth century saw the development of diverse theories responding first to fragmentation and then to disorder. Organismic biology, ecology, and Gestalt psychology developed discipline-specific holistic approaches early in the century. General systems theory, cybernetics, and operations research abstracted those approaches and developed general holistic principles around mid-century. And late in the century, theories of complex systems, chaos, and fractal geometry connected those principles to a reinterpretation of order and disorder. The mutually exclusive categories of order and disorder were augmented by the concept of "uncertain order", and the quasi-disorder of chaos and complexity were distinguished from the complete disorder of purely random behavior. Early notions of simple order are being replaced by the idea of complex order.

Interdisciplinary studies became accepted in the last quarter century within mainstream higher education and research as the methodology for pulling together reductionist and holistic approaches, thus overcoming the trend towards fragmentation. It achieves a

holistic understanding not by rejecting reductionism but by building on it. Interdisciplinary study complements the disciplines rather than substituting for them. That combination of holism and reductionism makes it possible for interdisciplinary study to address complexity as well as fragmentation. Thus interdisciplinary study addressed as well the growing awareness that disorder is endemic in our world, not by rejecting the search for order but by seeing the fundamental connection between order and disorder. Interdisciplinary study addressed the unraveling of simple order by providing a way to give meaning to the quasi-order found in complex systems.

Much of the literature on interdisciplinary studies makes vague reference to its application to complexity, and some of the literature on complexity casually refers to systems theory as an interdisciplinary approach. But, for the most part, the literatures on complexity and interdisciplinarity have been quite separate. This article focuses on their interrelations.

2. Interdisciplinarity Defined

Interdisciplinarity or interdisciplinary study (IDS) is a process of inquiry that is especially useful for the study of complex systems. In their overview of interdisciplinary studies, Klein and Newell define them as "a process of answering a question, solving a problem, or addressing a topic that is too broad or complex to be dealt with adequately by a single discipline or profession ... IDS draws on disciplinary perspectives and integrates their insights through construction of a more comprehensive perspective."

Interdisciplinary study is frequently distinguished from *multidisciplinary* study, which draws from the perspectives of different disciplines without attempting to integrate their insights into a more comprehensive understanding. It is also distinguished from *transdisciplinary* study, which takes a unified approach to knowledge (such as Marxism) instead of restricting its focus to a single issue, problem, or question by attempting to integrate the disciplines themselves as well as their insights. Similar but less commonly used is "cross-disciplinary", which refers to studies that apply the concepts, theories or methods of one discipline to the characteristic subject matter of another discipline (for example, the physics of music). Scholars who reject the disciplines altogether as arbitrary or illegitimate in favor of direct confrontation with phenomena may be characterized as "a-disciplinary", and scholarly work from eras that predate the separation of inquiry into distinct disciplines may be labeled "pre-disciplinary." Finally, there is some sentiment in the United States for using the term "*integrative*" to draw attention to the chief distinguishing characteristic of interdisciplinary study, namely integration. Hence the U.S.-based professional organization for interdisciplinary teachers and scholars is the Association for Integrative Studies.

These approaches all share a desire for *holism* and a frustration with fragmentation of knowledge, though they differ over the utility and appropriate role of disciplines in a holistic approach. In the United States, interdisciplinary or integrative study has gained favor over the other approaches since the1970s for several reasons. One is its pragmatic success in addressing complex real-world problems, affecting both current practitioners

and students in professional schools who will face such problems in the future.

Another is the range of intellectual abilities developed in students through interdisciplinary courses: outcomes such as critical thinking, contextualization, reflexivity, creativity, openness to new ideas, tolerance of ambiguity, sensitivity to bias, ability to see different sides of an issue, empathy, respect for different value systems, and familiarity with the perspectives of different disciplines.

Similarly, the freshness of approach from stepping outside the perspective of their home discipline leads to faculty development for those teaching interdisciplinary courses.

Yet another is the fundamental re-examination which interdisciplinary study occasions through freedom from restrictive assumptions of any one discipline, leading to radical social, political, or epistemological critiques.

More generally, its growing popularity may be due to the balance it provides between reductionism and holism, complementing disciplines rather than supplanting them.

There is no settled consensus about the details of the interdisciplinary process. Nonetheless, most interdisciplinarians would feel comfortable with these steps:

A. Drawing on disciplinary perspectives –

• *Defining* the problem [question, topic, issue];
• *Determining* relevant disciplines [interdisciplines, schools of thought];
• *Developing* working command of relevant concepts, theories, methods of each discipline;
• *Gathering* all current disciplinary knowledge and *searching* for new information;
• *Studying* the problem from the perspective of each discipline;
• *Generating* disciplinary insights into the problem.

B. Integrating their insights through construction of a more comprehensive perspective --

• *Identifying* conflicts in insights
  * Using disciplines to illuminate each other's assumptions;
  * Looking for different terms with common meanings, or terms with different meanings;
• *Evaluating* assumptions and terminology in the context of the specific problem;
• *Resolving* conflicts by working towards a common vocabulary and set of assumptions;
• *Creating* common ground;
• *Constructing* a new understanding of the problem;
• *Producing* a model [metaphor, theme] that captures the new understanding; and
• *Testing* the understanding by attempting to solve the problem.

The apparently linear nature of these steps is misleading because, as this entry points out, they are applied to complex systems dominated by nonlinear relationships. In practice, the process turns out to be complex as well.

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Biographical Sketch

William Newell is a professor of interdisciplinary studies at Miami and directs the Institute in Integrative Studies. He was the founding president of the Association for Integrative Studies in 1979 and currently serves as its executive director. He has published extensively on interdisciplinary studies and serves

frequently as a consultant or external evaluator to interdisciplinary programs. His research focus is on interdisciplinarity and complexity, especially as applied to public administration.