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Complex System Science and Discipline-Straddling Theories

When something is complex, it is composed of interconnected parts. Thus, in complex system science, researchers are supposed to address all relevant variables of a particular system or problem by fusion of unrelated but relevant disciplines. This kind of science holds the vision that fundamentally new phenomena may rise from the collective interactions of large numbers of factors that cannot be adequately studied by disciplinary measures in confinement. Complex systems come in many shapes, designs and sizes. They range from the smallest of systems like cell biology and the functioning of the human brain to the largest of systems like climate formation, biodiversity and ecology.

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In their book *Frontiers of Complexity*, Peter Coveney and Roger Highfield define complex system science as a new way of thinking about the collective behaviour of many basic and interacting units that lead to coherent collective phenomena existing at higher levels than those of the individual units, and *where the whole is more than the sum of its components*. Steven Weinberg, in looking at nature at levels of greater and greater complexity, sees phenomena emerging that have no counterparts at the simple levels, least of all at levels of the elementary particles: He sees nothing like intelligence on the level of individual living cells, and nothing like life on the level of atoms and molecules.

The quest to understand the "extras" stemming from the dynamics of interconnected parts belongs to the biggest and most demanding challenges in modern science. To know the individual bits and pieces of complex systems is not the same as understanding how the "extras" of wholes form and emerge. In acknowledging the enormity of this task, my ambition in this article is one of extreme moderation, addressing, in the form of a brief sketch, the ability of discipline-straddling theories to pick up and integrate bits and pieces of complex systems across disciplinary delineations.

Discipline-Straddling Theories.

Scientific theories, defined as a consistent set of ideas and/or variables about how a phenomenon works, are often diffused through and across disciplinary boundaries. They posses integrative power, i.e. the ability to piece perspectives, knowledge, ideas, concepts and data together into a whole. The integrative potential of theories makes them to a large, if not absolute, extent *discipline-neutral*. Even theories developed within the confines of a particular discipline have been adopted by other disciplines, helping the "borrowing" discipline to conceive of phenomena in new and broader ways. This is how discipline-based theories become discipline-neutral or discipline-straddling. In the last section of this book, *turbulence theory* – developed within the field of physics – has been applied to selected topics of linguistics and psychology to illustrate the unleashed integrative potential of discipline-based theories, the overall assumption being that there may be a flora of discipline-based theories in the inventory of the sciences that go far beyond the integrative confines of their mother-discipline.

In principle, one can distinguish between three interrelated and partly overlapping categories of discipline-straddling theories: *Synthetic theories*, *Interfield theories* and *Seminal theories*.

Synthetic theories

In the early 1970s, Jean Piaget made the case that a theory of interdisciplinarity should be based on common structures to be developed from the holistic perspective of systems theory concerned with patterns and interrelations of wholes. Piaget acknowledged that, when it comes to building blocks, a system in the social sciences is, in principle, no different from a system in the natural sciences, or for that matter between natural science disciplines.

Fifty years earlier, the Norwegian biologist, Johan Hjort observed that the word *organization* is a biological expression for the same thing as is known in physics and chemistry as a *system*. On this account, he concluded that the two concepts, 'organization' and 'system' reveal to us "the unity in our mind from which they both arise." Thus, system theory refers to a theory that is applicable to many systems – social as well as natural – and which is built on a set of interrelated concepts to be jointly used in system analysis in all sciences. These concepts, although varying in content between the fields, become operational for interdisciplinary undertakings through a process of mutual adjustment to each other. Julia Thompson Klein points out that these theories have been used to strengthen theory in one discipline, to unify a single discipline, to provide an integrative methodology or theory of cluster of disciplines, and even to function as a unified science by integrating all disciplines around a single transcendent paradigm.

Interfield theories

A distant relative of synthetic theories is interfield theories, which seek to identify relationships between phenomena in various *fields of inquiry*. A field of inquiry is defined by: *a central problem*, *facts related to a problem*, *techniques and methods applicable to a problem*, and *goals and factors providing clues as to how the problem is to be resolved*. The motivation to develop an interfield theory arises when researchers recognize that the phenomenon in which they are interested are connected to phenomena in other disciplines. The pooling of disciplines in cognitive science is an example of how interfield theories develop. Here the broadly based disciplines of psychology, artificial intelligence, linguistics, anthropology and philosophy are united by a common field of inquiry: *cognition*. Given that the goal of an interfield theory is to identify these relations, there is no need or demand to derive a theory of one field from that of another. An interfield theory opts to reveal relations between phenomena in different fields, for example to identify in one field the physical location of an entity or process discussed in another, frequently revealing a part-whole relation between the entities studied in the two fields. It may also identify an entity characterized physically in one field with the same entity characterized functionally in another, or it may locate in one field the cause of an effect recognized in the other field. To succeed in building interfield theories, no attempts should be made to make the theory of one discipline work for another, but rather to draw useful connections between the investigations of all involved disciplines.

Seminal theories

Seminal theories are discipline-straddling in that they are basically defined at the junction between fields. For the sake of illustration, let us take the examples of game and regime theories. Game theory has been applied in economics and finance, psychology, biology, political science, law, military planning and strategy etc., whilst regime theory has been used in disciplines like sociology, economics, geography, political science, international law and biology. Since these theories are applicable to all these disciplines the probability is that they may also be used to pool the same disciplines together in a unified holistic perspective. Some of the bridging potential of regime theory has already been tested.

In 1989 Kenneth W. Abbott published an article in which he argued that regime theory holds a rich potential to close the gap between international relations theory and international law. He even went so far as to call for a 'joint discipline' between law and political science. In a follow-up article some years later, Anne-Marie Slaughter et al., concluded that international relations theory and international law have rediscovered each other and that a new generation of interdisciplinary scholars has emerged, acknowledging that the disciplines represent different faces of and perspectives on the same empirical and/or intersubject phenomena. On the basis of their analysis of the inventory around which international relations and international law scholars converge, the authors suggested the establishment of 'joint disciplines' between the two domains when it came to 'international governance', 'social construction' and 'liberal agency'. In addition, the focus on substantive themes cross-cutting established paradigms and self-defined disciplinary boundaries made the authors suggest six clusters of research questions on which collaborative interdisciplinary research agendas could be built. These clusters fall under the headings of *regime design*, *process design*, *discourse on the basis of shared norms*, *transformation of the constitutive structure of international affairs*, *government networks* and *embedded institutionalism*.

The Integrative Reach of Scientific Theories

These categories of theories all possess synthetic power. Synthetic theories are based on a common denominator, system, which is a feature of both the social and natural worlds. As such, synthetic theories may be applied to pick up the bits and pieces of complex systems spanning the human-natural divide, for example global climate change. Interfield theories also bridge this divide, but offer a supplement to the approach of synthetic theories in that the former have no pre-defined theoretical outlook or common denominator to start with. Theories built within a variety of fields of inquiry develop gradually as the empirical research process evolves and will differ between the fields. In this way, interfield theories carry thematic flexibility and complementarity to the integrative potential of the other categories of theories. Seminal theories are thematically and problem-oriented, and since problems usually do not come in discipline-shaped forms, these theories are by definition established at the cross-section of disciplines – as a common property of fields. Problems know no disciplinary boundaries.

Although, theoretical approaches of this variety span the divide between the natural and social sciences, their integrative reach is still limited. Their thematic focus is restricted to specific issue areas, for instance systems and regimes, and to an endless variety of restricted fields of inquiry. They are synthetic within restricted scopes, covering only limited clusters of phenomena across fields. As such, they do not fulfil the ultimate dream of a final *theory of everything* – of total consilience between all sciences and disciplines. Such a task is itself beyond any one human mind, and inherently undoable due to the fact that knowledge expands faster than ways to categorize it. Ken Wilber sums it up nicely: "The holistic dream is an ever receding dream, a horizon that constantly retreats as we approach it, a pot of gold at the end of a rainbow that we will never reach. So why even attempt the impossible? Because, …, a little bit of wholeness is better than none at all, and an integral vision offers considerably more wholeness than the slice-and-dice alternatives. We can be more whole or less whole; more fragmented, or less fragmented; more alienated, or less alienated – and an integrated vision invites us to be a little more whole, a little less fragmented, in our work … (Wilber, p. xii)."

Complex system science does avail itself of multiple integrative measures in which both discipline-based, synthetic, interfield and seminal theories are part of the inventory. To gain more in-depth knowledge about the extras of wholes – some of which may never be fully understood – there is a need to increase the integrative power and scope of all available means of integration, theories included. The rich stock of discipline-based theories may unleash some unrealized interdisciplinary potential through wider applications (See last section of this book), whereas discipline-straddling theories may increase their collective integrative ability by combined applications to serve as complementary and supplementary means of convergence.

References

Abbott, Kenneth W.: "Modern International Relations Theory: A Dual Agenda" in *Yale Journal of International Law*, vol. 14, 1989

Bechtel, William: *Philosophy of Science: An Overview of Cognitive Science*, Lawrence Erlbaum Associates Publishers, Hillsdale, Hove and London, 1988

Coveney, Peter and Highfield, Roger: *Frontiers of Complexity. The Search for Order in a Chaotic World*, Fawcett Columbine, New York, 1993

Darden, L and Maull, N: "Interfield Theories" in *Philosophy of Science*, vol. 44, 1977

Davies, Paul: *God and the New Physics*, A Touchstone Book, New York, London, Sydney, Tokyo, Singapore, 1984

Hjort, Johan: *The Unity of Science*, Gyldendal, London, Copenhagen, Christiania, 1920

Klein, Julia Thompson: *Interdisciplinarity. History, Theory and Practice*, Wayne State University Press, Detroit, 1990.

Piaget, Jean: "The Epistomology of Interdisciplinary Relationships", in Interdisciplinarity: Problems of Teaching and Research in Universities, OECD, Paris, 1972

Slaughter, Anne-Marie, Tulemello, Andrew and Wood, Stephen: "International Law and International Relations Theory: A New Generation of Interdisciplinary Scholarship" in *The American Journal of International Law*, vol. 92, 1998.

Weinberg, Steven: *Dreams of a Final Theory. The Scientist's Search for the Ultimate Laws of Nature*, Vintage Books, New York, 1993

Wilber, Ken: *A Theory of Everything. An Integral Vision for Business, Politics, Science and Spirituality*, Shambhala, Boston 2000

Wilson, Edward O.: *Consilience. The Unity of Knowledge*, Vintage Books, New York, 1999

Østreng, Willy: *Science without Boundaries. Interdisciplinarity in Science and Politics*, forthcoming book, 2006