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COMPLEXITY

*unruly and otherwise**

RICHARD BAWDEN

COMPLEXITY IS, AS THEY SAY, everywhere you look these days. Of course, it has been there all along, but only recently has its significance become appreciated, particularly as it relates to challenges to the human condition (Gleik 1987). Along with growing concerns about the impacts of human activity on the sustainability of life on earth, and the truly global spread of the “bads” as well as the “goods” that so entertains the minds of those concerned with the trajectory and dynamics of the modernization project (Beck 1992), complexity has become one of the Hydratic heads of the contemporary problematique: indeed, it is probably its most defining characteristic, being the very essence of a host of phenomena, ranging from the relationships between fossil fuel carbon emissions and changes in the climate of the globe, through to the transnational dynamics of violence rooted in clashes of civilizations. The ubiquity of complexity has captured the attention of a community of researchers from a diverse spectrum of academic disciplines that, in the manner of these things, has spawned its own scientific domain (Capra et al. 2007). The complexity sciences had their genesis some 50 years ago in the work of a number of scientists in different disciplines who initially were working independently of each other. Although yet to assume

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the respectability of an institutionalized scientific discipline or meta-discipline, those working in the complexity sciences are committed to the dual quest for theoretical understanding of the nature of complex phenomena, and for generating processes and strategies for dealing effectively with them. Because the focus of this praxial work is both understanding and action, it is somewhat ironically creating its own internal dialectical complexity through the interrelational tension between abstract interpretation and concrete engagement.

In the commonsense view of everyday life, things, events, and phenomena—including, and perhaps especially, those associated with human endeavors—are considered complex whenever they are composed of a multitude of different component parts that are seemingly too numerous to count. From this perspective, a Boeing jet airliner, with its many hundreds of thousands of parts, is a complex machine, just as the universe, with its literally innumerable heavenly bodies in an incomprehensibly enormous volume of space, is a vast complex on an unimaginable scale. Then, too, there is the notion of complexity that has to do with the contingent nature of the interrelationships between different interconnected things or events or, indeed, of different ways of coming to know them. There is an important difference between these two perspectives: in the first instance, in principle at least, the object in review is essentially knowable, and its “behavior” therefore theoretically predictable. It might be better to refer to this circumstance as “complicated” rather than “complex.” In the second case, the inherently contingent nature of the outcomes of the often synergistic interactions between what are often considered to be different parts of some form of coherent whole, makes the behavior of that whole at best exceptionally unpredictable, and at worst quite unknowable in any usable detail. While a marriage in Western society is (typically) only between two people, the relationship between them, which involves potentially very significant differences in beliefs, values, motivations, habits, and so on, can be extraordinary complex. This interpersonal situation is greatly amplified by scale as the relationship is further extended beyond the couple to include all of the individuals within an entire family. And complexity piles upon complexity as the level of collective organization is further extended beyond the family to embrace the tribe, or the village, or the sect, or formal organizations, or informal institutions, or whole civilizations, or nation states—and so on and so forth.

Moreover, this aspect of “true” complexity is by no means exclusive to human organization, for the rest of nature also seems to be replete with complexity. Phenomena in the natural world seem to be characterized as much by nonlinearity and the indeterminacies of synergy and chance, as by the determinism of the mechanistic linearity that has for so long been the intellectual framework of conventional science. The notion is beginning to emerge, within the complexity sciences at least, that the whole momentum of evolution of the biophysical reality of this planet is toward ever-greater complexity, albeit progressing through punctuated fits and starts, with periods of dynamic stability alternating with

times of utter chaos. And this theory is no longer confined solely to an ontological interpretation of the “nature of nature.” The transfer of concepts and principles born of the complex nature and behavior of biophysical systems is inspiring much of the work in social systems, with all of their normative and empirical dimensions. This synthesis is playing an important role in the emergence of complexity theory as an inter- or trans-disciplinary conceptual foundation for understanding the common nature and dynamics of both social and natural systems—and for understanding the interrelatedness of each of these types of systems with the other—as the basis for improving the way we deal with the world about us.

There is a signal importance here of the emphasis on “systems”: bounded whole entities, with structural and functional integrities that are held to be related to—and expressions of the nature and dynamics of the interrelatedness of—the “lower order” subsystems that constitute their component parts, as well as of their own interrelationships with the “higher order” suprasystems of which they themselves are part. A central assumption of all systemists is that distinctive properties emerge at each change of level within this hierarchically organized “system-of-systems.” Accordingly, the properties of systems are unpredictable from studies of any of their component subsystems or even of the interrelationships among them: the whole is different from the nature of any of its parts (if not, as is frequently claimed, more than their sum).

From this perspective of emergent properties, all systems are complex to some degree or another; the focus of the complexity sciences, however, tends to be on a special category of particularly dynamic and resilient systems that have the capacity for self-organization and self-stabilizing adaptation in the face of turbulent, literally chaotic, challenges from the environmental supra-systems in which they are embedded. When the level of chaos in the environment is so great as to threaten the integrity of these complex adaptive systems, the systems are able to transform themselves (self-organize) into higher-order levels of organization, with increased structural complexity and seemingly enhanced coherence, and with internal, yet still dynamic, stability leading to a new meta-equilibrium.

That’s the essence of the theory at least. Empirical evidence to support this theory is being sought by those who wish to devise sounder socio-ecological strategies for the sustainable management of “nature,” as well as those who seek generic understandings of the “real” organizational nature and evolutionary dynamics of equilibrium-seeking complex adaptive natural and/or social systems. The questions that these studies generate not only get to the very nature of nature, but also extend to embrace the nature of knowledge, the nature of human nature, and the nature of human inquiry—and thus constitute what some see as the four domains by which different scientific paradigms can be categorized (Guba and Lincoln 1989).

Is nature really organized as a hierarchy of intrinsically resilient, complex, adaptive, self-organizing bounded ecosystems that constantly seek to maintain

their own functional and structural integrity and some level of stability or dynamic equilibrium, even in the face of the chaotic turbulence of the higher-order supra-systems in which they are embedded? And if so, do such ecosystems inevitably evolve towards ever-increasing complexity? What role do human beings play in the organization and dynamics of natural systems, and do social systems have properties and dynamics analogous to their biophysical counterparts? What are the implications of exploring complexity from a perspective of “intersecting processes,” rather than “well-bounded systems”? How can researchers come to know the “true” answers to any of these questions, including questions about the nature of truth itself and how it can be known? How can scientists even come to engage objectively with the issues, given the essentially normative socio-politico-cultural realities in which they must operate? And how is any of this relevant to the development of more responsible environmental management practices, or of defensible strategies for nature conservation, or of the sustainable development of natural resources, all under circumstances where citizen participation and public judgments are central to all of these issues within democratic societies?

Peter Taylor, a self-confessed ecological scientist-cum-activist, enters this messy fray from a refreshingly novel and delightfully appealing perspective—that of an interest in and concern for the implications of what he refers to as “unruly complexity”: situations that he argues are characterized by a lack of “clearly defined boundaries, coherent internal dynamics, or simply mediated relations with their external context.” What, he muses, might be the significance, to both ecological theory and its application in practice, of exploring complexity “without assuming the existence of well-bounded systems”—indeed by assuming a perspective of “intersecting economic, social and ecological *processes* that operate at different scales,” that “transgress boundaries, and restructure ‘internal’ dynamics”? Might bounded, functionally coherent systems be the exception in both complex natural and social organizations, rather than the rule? And what might all of this mean with respect to ecological knowledge, what counts as knowledge, and how it is generated, interpreted, and used? What might the implications of an awareness of these issues be, for the way that ecologists (and indeed scientists in general) ought to go about their work?

Unruly Complexity: Ecology, Interpretation, Engagement is not a study of complexity per se—unruly or otherwise—nor is it an exposition of how it might best be investigated through modeling, although both of these themes do feature in the text. Rather, as the author pronounces at the outset, the essential theme of the book is a critical look at a trinity of interconnected domains or “realms” of science (and most especially ecology), of the interpretation of science, and of critical reflection on scientific practice. The author’s search for a theory or model to explicate “ecological complexity” leads him eventually to invite other researchers “who want to reconstruct the unruly complexity of ecological and social situations” to become more self-conscious about their engagement with “the

complexity of the situation studied” and with “the social situations that enable them to do their research.” Taylor suggests three angles or “facets of crystal” from which to view the practice of researchers: their study of complex situations; their attempts to establish what counts as knowledge through interactions with other social agents; and their efforts to pursue responsible social change, “in which they address self-consciously the complexities of their own situatedness as well as the complexities of the situation studied.”

This is a radical stance, and many will find discomfort in its provocations, whether they are of the conventional school of exploring simplicity from this side of complexity, or, as the complexity scientists are so doing, from the other side. Yet this should certainly not deter readers from staying with a seductive story that illuminates some very powerful arguments central to science and its role in society. As one of the reviewers in the blurb on the back cover suggests, Taylor boldly challenges accepted distinctions between science, interpretation, and engagement that have persisted since the very dawn of modern science.

The praxial emphasis of the book is reflected in its intended target readership—always a matter of particular interest to publishers and reviewers alike. This, as the author envisages it, is not limited to “ecologists and socio-environmental researchers, modelers and theorists of complexity in biological and other systems, interpreters of science, and educators and activists in environmental or scientific politics”—even though Taylor surmises that an exploration of unruly complexity will resonate with their concerns. Rather, his aim is to reach a constituency that shares three particular qualities: an interest in exploring new propositions, themes, and questions that might provide them with fresh perspectives to their own inquiries; a sense that conventional disciplinary boundaries present impediments to their work; and a disposition to reflect critically on the conceptual and practical choices they have made in relation to alternative positions and possibilities—and choices that they might make in the future.

The temptation when writing about a topic like complexity, even when it is explored from the context of a progression from science to engagement via interpretation, is to write about it as an impersonal or depersonalized set of conceptual propositions that may or may not be accompanied by empirical case study examples. A second option, one that is increasingly fashionable within the broad sweep of the particular topic area of complexity, is to write an ethnographic narrative of those who have made contributions to the field or have explicated the challenges, outputs, and personalities of those engaged with the work. A third, increasingly popular, approach is to explore the practical implications and applications of complexity theory as they pertain, for instance, to the effective pursuit of the sustainable management of organizations, or of the sustainable development of natural resources, or of responsible management strategies for the conservation of nature. Taylor’s *Unruly Complexity* has elements of all of these relatively common genres, as he employs a powerful diversity of literary techniques with which to engage his readership. The author’s decision to add

autobiography to this diversity adds even further richness to both the context and content of the narrative, while precisely exemplifying the very point of his arguments that it is virtually impossible—and not even sensible to attempt—to separate out the analyst from the analysis. In what amounts to a reflexive auto-ethnographic orientation, Taylor brightly illuminates the creative relationship between self-reflection on the personal and social and cultural interpretations: this becomes a text where the self and the situation under review become inextricably intertwined (Patton 2002).

In choosing to write himself into the book, Taylor provides an evocative illustration of a meta-narrative of personal transformations (and indeed career reorientations) that reflects the manner by which he himself exemplifies the three qualities that he projects for his readership. In this manner, he explicitly invites his readers to use this narrative as a source of reflections “on their own paths and positioning over time.” Those who read this book with a special focus on this meta-narrative will find much cause for reflection—on the connection between the progression of the ideas and the logic of the presentation as the narrative unfolds, on the one hand, and the changing motivations and personal reflexive experiences that the author concomitantly records as his history unfolds, on the other. As the systems principle of equifinality would suggest, while the destination of different knowing or inquiring systems might be similar, the initial conditions and the detailed excursions of the evolutionary journeys that are pursued to reach it will often differ very substantially. Paradoxically, the sheer idiosyncratic nature of such journeys can be a cause of tension between reader and writer—for there certainly will be those who believe that the author has missed significant bodies of literature that could have added much to his arguments or provided a rich dialectic through sourcing rebuttals for some of his assertions. But then all systems have, by definition, boundaries—and a book is no exception.

This book creatively illustrates the emergent principle that a well-reasoned, diversely presented, and amply illustrated narrative comes to be much more than the sum of all of its parts—and in this case, a critical heuristic emerges. There is thus a strong incentive for the reader to learn from the author’s fascination with unruly complexity, which, he posits, arises whenever there is “ongoing change in the structure of situations that have built up over time from heterogeneous components that are embedded or situated within wider dynamics.”

Taylor, like many others who are interested in the phenomenon of ecological complexity, started his career through a practical application of ecological theory in mathematical modeling. Yet from the get-go, he clearly establishes himself as a trans-disciplinary boundary-buster: not only, as a modeler, does he move with apparent ease across the boundaries of the natural and the social sciences (and indeed between science and philosophy, too), but he critically questions the whole idea of “boundedness” while reviewing the constraining implications of thinking about nature and society in terms of coherent systems.

His first job, as an agricultural researcher in Australia, was to model the com-

plexity of interactions between different plant varieties and field conditions in large crop trials, while his second job involved modeling the economic future of an irrigation area in which the process of irrigation was contributing to the salinization of the soil. Disturbed by the manner by which this latter work was “distorted” in its selective use by his government sponsors, Taylor became interested in the social and political implications of his work. This led him to further studies, this time in the United States, that would reflect a profound shift in his focus, from questions of conceptualizing “life’s complex ecological context” to ones of conceptualizing “science’s complex social context.” The story of unruly complexity and how Taylor came to it unfolds in a compelling and singularly complex manner—which, inasmuch as the text is elegantly and logically organized in a flowing form, with “clearly defined boundaries [and] coherent internal dynamics,” is non-unruly.

The author has organized his book into three parts that illustrate the “three crystal facets” of research practice already mentioned. Thus, the first section of the book deals with modeling ecological complexity; the second with interpreting ecological modelers in their complex social context; and the third explores reflexive engagement within ecological, scientific, and social complexity.

In the first section of the book, Taylor introduces some of the basic questions that address relationships between models and the reality of ecological systems, as well as the “truthfulness” and usefulness of ecological theories. He cogently explores relationships between complexity and some of the problematic features of such systems, including the phenomena of system stability, of internal coherence, of heterogeneity and embeddedness, and, most essentially, of boundedness. The self-styled “constructionist” view that he explicitly assumes provides the context for him to tease out a number of significant propositions relating to ecological modeling and theorizing. Each of the issues that he pursues here certainly challenges conventional ecological views, including notions about equilibrium and persistence. Perhaps his most unsettling submission to conventionalists, however, is his assertion that “complexity is better conceived in terms of intersecting processes than well-bounded systems.” The property of systemicity—or “systemness” as he calls it—should not be the starting point for theory and modeling, but “a contingent outcome to be explained.”

While he discusses the modeling of ecological complexity, the author also introduces the diversity (and complexity) of the different genres that he will employ throughout the rest of the text. There are historical commentaries, empirical observations, peer citations, personal narratives, virtual dialogues, assertions, and a rich variety of different forms of graphic illustrations, including diagrammatic models. He uses all of these devices to great effect to support his shibboleth-shaking conclusion that “ecologists cannot establish a relationship of models to ecological phenomena without making decisions in which something other than experiments, observations, and comparisons must come into play.” And this contention provides the perfect segue into the next phase of his story,

which parallels the shift in the focus of his career from scientific modeler to interpreter of science.

In the second part of the book, Taylor turns his critical spotlight on the interpretation of ecological modelers in their complex social contexts. Some interpreters of science, he submits, focus on the issue of referentiality and what constitutes improvements in scientific knowledge, while others are more interested in the impact that social factors have, not just on matters to do with knowledge in science, but also on the direction that the pursuit of such knowledge takes. Not only do scientists seek to develop their models of reality, but they also seek to enable others to act on their conclusions. It is this latter “deeper sense of sociality” that commands Taylor’s attention, for from such a perspective it is much harder “to keep sociality and referentiality separate.” It is plausible, he muses, that “the simultaneous pursuit of referentiality and social support could sometimes lead to systematic and enduring effects on the content of scientific knowledge.” If ecologists concerned with complexity—as well as researchers more generally—were more aware of this situation, he posits, they might be far more circumspect and critical about the way that they currently go about their work.

To illustrate his contentions about social–personal–scientific correlations, Taylor turns his attention to historical interpretive analyses of the work and times of a number of ecologists, with special attention to H. T. Odum and his work with “designing systems of man and nature” during the era of techno-centric ascendancy in post–World War II America. Taylor argues that the emerging culture of technocratic optimism greatly amplified Odum’s access to resources that enabled him to conduct an enormous volume of ecological research, while also both influencing his “life experiences as a scientist” and “shaping his scientific theories.” Odum would come “not only to *think* that ecosystems are *like* feedback systems and energy circuits, but to *act as if* they were systems and circuits.” In turn, these events and ideas played a significant role in the way key decision makers in society came to view the interrelationships between people and nature, and how they might be “engineered” in the quest for improvement. Odum was, Taylor surmises, “able to find in nature, a special role for systems engineers, such as himself, working in the service of society.” With an unrelenting focus on energy as the currency of his ecological perspective, and his search for ways of connecting theory with intervention, Odum introduced a vitally fresh dimension to the scientific study of ecology and ecosystems that helped to provide a host of new insights about people, nature, and their interrelationships. As his work progressed, however, this focus was to prove somewhat restrictive to both theory and practice, while his adherence to the principle of stability triggered considerable skepticism among other systems ecologists.

Taylor then turns back to the issue of modeling in “real world” socio–environmental assessment projects to explore some of the further complexities and contestable pragmatics of the sociality/referentiality issue. He selects two project cases. The first involves his reconstruction of the work on the future of a salt-

affected agricultural region in Australia, through an integrated inquiry into the “processes about making science and the interpretation of those processes.” In this context, and through his “brief and partial” reflections on this project, he introduces six interrelated propositions that are central to the arguments in the remainder of the book: (1) science-in-the-making depends on heterogeneous webs, not unitary correspondence; (2) scientists represent-engage; (3) scientists are practically imaginative agents; (4) the agency of heterogeneous constructors is distributed; (5) resources are causes; and (6) counterfactuals are valuable for exposing causes.

These propositions are then explicated in the analysis of a second modeling project (in which the author himself was not directly involved) that was funded by the U.S. Agency for International Development in the early 1970s. The aim was to develop long-term development strategies for the semi-arid Sahel region of western Africa, which, through drought and related famine conditions, was in crisis. Taylor describes many of the contentious and contestable social and political outcomes of the systems dynamics modeling approach that was adopted, and how it was used to different effects by different stakeholders in the project. Then, using counterfactual analysis, he critically explores alternatives to a number of specific aspects of the project while teasing out their practical implications. He demonstrates how scientists harness many diverse sources in establishing knowledge: “This process of heterogeneous construction is always, in practice, bound up with construction of lives, careers, institutions, language, ideologies, societies—that is with a range of actions and engagements.”

And it is to reflexive engagement with ecological, scientific, and social complexity that the author shifts his emphasis for the final section of his book. The intention here is to explore the significance to researchers of self-consciously addressing the “complexities of their own situatedness,” as well as the complexities of the situation under study. The final section privileges the application of the ideas that have been rehearsed throughout the first two sections of the book. This praxial turn is as laudable as it is necessary, for the apogee of the author’s message is the translation of ideas into actions. As the author himself admits, while the work that he has described up to this point has suggested that awareness and discussion among ecologists about the sociality of their science could influence “their subsequent work in productive ways,” it remained “an open question how best to feed interpretation back into science.”

Initially impressed by the adaptive environmental management approach (Holling 1978), and subsequently further inspired by the ideals and work of participatory action researchers, Taylor turns to the challenges that he has confronted in attempting “to distribute the work of interpretation and engagement to others.” Reflecting on work that he conducted in this context, first with fellow scientists and then with his own students, he draws two significant conclusions: all research involves heterogeneous construction—including the work of

interpreters of science; and those who interpret science as heterogeneous construction need to ensure that the work of interpreting and engaging with that research is distributed. As he sees it, there is somewhat of a paradox here. Even as one stimulates others “to identify the diverse resources mobilized by particular agents who span different domains of social action,” conceptual and methodological choices are made that push sociality, of both facilitator and “audience,” into the background. This situation does, however, provide a fine motivation for practical reflexivity.

In a final chapter, Taylor introduces a matrix which interrelates three formulations of complexity with his three “crystal angles” from which to view the practice of researchers. He then further expands upon each of the nine resulting conjunctions, while exemplifying “opening-up” themes and questions that each in turn motivates. Such a framework, he contends, represent two further additions to the toolbox that he uses to “nudge audiences in the direction of attending to particular distributed dynamics and of contributing self-consciously to knowledge-making and social change.” Between this final chapter and the valuable list of references that finally brings closure to the somewhat complex narrative and meta-narrative alike, the author inserts a meaty epilogue, a summary of “themes and questions opened up,” which he cleverly illustrates with a simple graphic, a useful glossary of terms, and a comprehensive set of endnotes.

It is as if, in its own unruly complexity, the book, or at least its author, is not certain where or when to come to an end—but that is perhaps the essential message after all, for as he points out, the book doesn’t provide a theory in explanation of unruly complexity in any specific arena or circumstance, “but opens up issues about addressing complexity in ways that point to further work that needs to be undertaken to deal with particular cases.” In this sense it is an unbounded endeavor, and the author is to be applauded for providing structured motivation for engagement with this grand and vital venture.

Whichever way we look at it, whichever ontological, epistemological, and axiological stances we assume, and whichever methodological approaches we adopt, complexity is increasingly going to demand our engagement. As the defining character of this risk society, its characteristics are going to increasingly confront us—scientists and citizens alike—with challenges that will stretch our intellectual, moral, and praxial competencies to their very limits. It is incumbent upon all of us to confront these realities with the type of critical self-reflexivity of our own complex situatedness for which Taylor so stridently calls. Engagement with self-confrontation provides an important motivation for reading this book—to say nothing of the seduction of the warp of an ethnographic narrative with its auto-ethnographic meta-narrative weft.

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