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Chaos and the Evolving Ecological Universe. Sally J. Goerner. Langhorne, Pennsylvania: Gordon and Breach, 1994, 255 pages, \$40.00 hard.

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"This book's thesis is that our time marks the emergence of a new world hypothesis based on the root metaphor of an evolving ecology" (p. 4). Goerner makes a point of arguing that a world hypothesis is like a paradigm shift (Kuhnian); only it is broader. If this book is about anything, it is about world views. The ideas of paradigms and world views are so fundamental to the book's thesis, broad-ranging implications, and conclusions, they deserve a separate discussion.

The purported "new" world hypothesis Goerner is telling us about is that we in science are beginning to recast the world in terms of conceptions and dynamics that are common to ecosystems, and to chaotic systems (deterministic nonlinear, unpredictable systems). This is the basis for the book's title. Goerner points out that these common conceptions and dynamics include, for example, interdependencies among systems, and spontaneous self-organization in systems. While I can understand Goerner's decision to more or less abandon Kuhn's (1970) analysis of scientific revolutions for the perhaps broader context of a "world view," I think the book suffered greatly from it. Many of Kuhn's conceptions would have helped put Goerner's story of the transformation from the old to the new into a more manageable perspective. For example, Kuhn's notion that paradigm changes are like switches in visual gestalt, and that paradigmatic conversions are not simply rational ones but involve a variety of interdependent psychological and sociological determinants, could have lent both mechanism and plausibility to the book's entire thesis statement (chapter 1). As it stands there is entirely too much rambling on about the limitations of the Newtonian world view, and the limitations of calculus.

Most of what is critically important in the first half of the book was already summarized nicely by Crutchfield, Farmer, Packard, and Shaw (1986):

The discovery of chaos has created a new paradigm in scientific modeling. On one hand, it implies new fundamental limits on the ability to make predictions. On the other hand, the determinism inherent in chaos implies that many random phenomena are more predictable than had been thought. Random-looking information gathered in the past — and shelved because it was assumed to be too complicated — can now be explained in terms of simple laws. Chaos allows order to be found in such diverse

systems as the atmosphere, dripping faucets and the heart. The result is a revolution that is affecting many different branches of science. (p. 46)

For an introduction to chaos theory and applications for psychology Abraham, Abraham, and Shaw (1990) is superior, and it is less cluttered than Goerner's presentation.

The second half of the book is devoted to "human dimensions of the ecological universe." For me, this is the better half. Goerner provides a good deal of insight into human and humanistic implications of an ecological world view. She discusses power, re-enchantment, reconciliation, and empowerment:

The power section [chapter] looks at how ecological perspectives are improving our understanding of economies and how they work. The chapter on re-enchantment explores the new science's consonance with long-standing spiritual traditions. The chapter on reconciliation discusses how the new physical view helps reconcile previously antagonistic philosophical traditions. And finally, the chapter on empowerment looks at how the new view changes our sense of how individuals fit in and affect the world. (p. xii)

Three General Precautions

First, in formulating the broad implications of the mathematical model of chaos, mathematical models in general must be differentiated from nature and other types of modeling. That is, the mathematical model of chaos "is" not nature; it is a model of nature that has limitations. For example, it might be a rather serious mistake to base a world view on a mathematical model that is subject to Gödel's incompleteness/inconsistency theorems. People who confuse mathematical models with the totality of reality are usually mathematical a priorists who believe that mathematics represent truths about some abstract realm, and, once proven, they are true for all time and all things. However, I believe we are steadily emerging from the mathematical a priorist paradigm (see, for example, Kitcher, 1983; Vandervert, 1993; Wynn and Bloom, 1992). In the meantime I ask only that we proceed with the philosophical implications of mathematical models using caution, not wild abandon.

Second, what is really behind the proposed new ecological world view? Is it actually chaos theory and ecological conceptions, or something the result of larger changes in science and society? Certainly one could argue, for example, that computers, world-wide communications networks, and systems-theoretical conceptions (which are essentially the same as and better integrated than those that Goerner offers) are now major forces in any emerging holistic world view. It was puzzling that Goerner did not mention the contributions of systems theory.

Third, it is my opinion that Goerner is guilty of way too much calculus bashing. After reading Goerner's account of the limitations of calculus one might wonder how science and technology have accomplished anything at all. And, there is another side to this. Goerner does not tell us, except in the most general terms, how the mathematics of chaos will help us find additional solutions to everyday problems in meteorology, engineering, stock market analysis, psychotherapy and, of all things, understanding the behavior of ecosystems.

The central themes of the book appear in earlier works by Goerner (for example, 1990a, 1990b). These papers have the advantage of getting directly to the point. On the other hand, one should not miss her well-developed material that appears in the second half of the book.

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