



Frontiers of Complexity

Roger Highfield

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At the cutting edge of the sciences, at the theoretical frontier where breakthroughs in a broad spectrum of fields intersect, a dynamic new concept is emerging: complexity.

In this groundbreaking new book, Peter Coveney and Roger Highfield, the scientist coauthors of the highly praised *The Arrow of Time*, explore how complexity in mathematics, physics, biology, chemistry, and even the social sciences is transforming not only the way we think about the universe, but also the very assumptions that underlie conventional science.

Coveney and Highfield define complexity as a watchword for a new way of thinking about the behavior of interacting units, whether they are atoms, bits within a computer, ants in a colony, or the neurons firing in the human brain. Complexity reaches far beyond the concept of chaos and represents a profound shift away from the reductive principle that has guided science for centuries, fostering a new synthesis of concepts across many disciplines. *Frontiers of Complexity* traces the history of how such giants of science as Charles Babbage, George Boole, Richard Feynman, Kurt Godel, John von Neumann, Ilya Prigogine, and Alan Turing built on each other's work, opening the way for the leap from reductionism to complexity.

As Coveney and Highfield so lucidly demonstrate, the rise of the electronic computer provided both the key and the catalyst to our exploration of complexity. A new generation of computers that runs on light, manipulates fuzzy logic, and exploits the bizarre properties of quantum mechanics, promises to deepen our understanding of complexity.

The advances we have already witnessed are spectacular. The authors take us inside a laboratory where scientists are evolving the genetic molecules that enabled life to emerge on earth. Coveney and Highfield describe the work of others who are generating universes in cyberspace filled with a vast array of organisms that compete for resources, reproduce, mutate, and evolve. We witness the utterly realistic behavior of a school of virtual fish--computer-generated replicas that have been trained to swim gracefully, hunt for food, and scatter at the approach of a leopard shark.

Already scientists have accurately modeled the brain of a bee, with its one million neurons. Others are beginning to reproduce the way the human brain processes vision, and even the way our genetic code can carry out "calculations" within every cell of our bodies. How much longer will it be before the computer unravels the mysteries of the one-hundred billion neurons of the human brain?

Compelling in its clarity, vast in its scope, far-reaching in its implications, vibrant with the excitement of new discovery, *Frontiers of Complexity* is an arresting account of how far science has come in the past fifty years and an essential guide to the rapidly approaching future.

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