CURRENT BOOKS

SCHOLARS' CHOICE

Recent titles selected and reviewed by Fellows and staff of the Wilson Center

CHAOS: Making a New Science
by James Gleick
Viking, 1987
352 pp. $19.95

A number of hardy souls have imprinted their attempts to imagine absolute disorder, or chaos, on the world's collective cultural record, but most of our intellectual energy, in science and in literature, in religion and the arts, and above all in daily life, has been directed at making sense of things, at finding order in the flux of phenomena and sensation. Indeed, some of the most striking attempts to represent chaos have come with our effort to imagine how order arose. These have left vivid traces in *Genesis*, in the Babylonian creation epic *Enuma elish*, in Hesiod's *Theogony* (where the word seems to have made its debut), in the Hindu *Rgveda*, in the Norse *Elder Edda*, in Ovid's *Metamorphoses*, in Haydn's *Creation*, and in the "Big Bang" of recent astrophysics.

Most attempts to imagine chaos, however, project a terminal condition of the decay of order, as in *Revelations*, Shakespeare's *Troilus and Cressida* and *King Lear*, in universalized thermodynamics, Picasso's *Guernica*, and the collected works of Samuel Beckett. Chaos, in the words of one of the most energetic promoters of the territories mapped and chronicled in this splendid book, has generally had bad press.

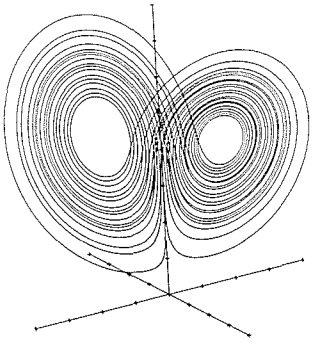
But in the "new science" that James Gleick shows emerging from the cloud of unknowing, "chaos" means something other than totalized and unqualified disorder. It even evokes classical notions of harmony in confusion, "Where," as Alexander Pope observed, "order in variety we see/And where, though all things differ, all agree." Chaos, Gleick acknowledges, is a shorthand, more evocative and more comprehensive than other descriptions of his subject, such as "nonlinear science." He homes in on "chaos, in the new sense: orderly disorder created by simple processes." At the same time, using a collection of definitions extracted from the scientists themselves, he demonstrates that chaos, in the new sense, resists definition. It is better represented as a set of ideas with family resemblances, more like a grid than a point or, rather, more like the staring shape (owl mask or butterfly wings) of the figure generated by a looping trajectory that never overlays itself—called the Lorenz attractor after its creator, research meteorologist Edward Lorenz.

To chart the emergence of this new science from a scattering of random and apparently disconnected events "in odd corners of different disciplines," Gleick invokes the notion of paradigm change, as set forth by historian Thomas Kuhn in *The Structure of Scientific Revolutions* (1962). In Gleick's version, accumulating dissatisfactions and anomalies on the margins of "normal science" create an instability wherein a small extra push by a few mavericks can have major consequences—namely, the cre-

ation of a whole new way of doing science.

Gleick, a *New York Times* reporter, is also interested in personalizing the story. Most chapters of his book have heroes, though in one instance it is a California collective, and in another a complex figure (Benoit Mandelbrot, an IBM scientist who developed the "Fractal Geometry of Nature") who is presented in an enigmatic light. The likeliest hero for the book as a whole is the physicist Mitchell Feigenbaum, not only for his self-forgetful charm and his literate eloquence but also for his mathematics. More than anything else, Feigenbaum's work provides a common grounding for the diversity of disciplinary pursuits within the new science.

In making much of the real-world applications of chaos theory, Gleick exploits the fascination of the real, starting with the weather and ending with snowflakes. But this strategy is tied to one of the profoundest issues threading the history of Western science: the relation of scientific description to the world of our experience. Much modern science—especially those branches most brilliantly successful in their pursuit of fundamentals—leads to an abstract world that is no longer even imaginable. The procedure of reducing a problem and the phenomena to their simplest elements, and of eliminating "accidentals," what cannot be generalized, and complexity itself, leaves out much of the continuum we inhabit.



The new science of chaos begins by claiming as its territory those regions that have seemed too disordered, too complicated, and too unpredictable to be nailed down by reductive analysis and generalization. Its investigators try to give an account of what actually happens when a stream breaks into rapids, or galaxies collide, or a heart beat goes wild, or clouds change shape, or populations or stock prices fluctuate. An account of such things as processes can show a path between simplicity and complexity: through iteration ("when things work on themselves again and again," as Feigenbaum puts it) and scaling (how "big details relate to little details"). The generative equations are, in fact, relatively simple and of wide application. Thus the tension between generalization and particularity is not banished in the new science but asserted in more intimate and inclusive relations with the world of everyday phenomena.

Chaos theory, as Gleick explains, entails a new confidence in visuality. As a working scientific tool, visualization had fallen much out of favor with some physicists and mathematicians precisely because it chains thinking to experience. By contrast, the new science puts to work the eye's gift for discerning patterns: by converting information into images on computer terminals and even making movies of the results; by making maps for differential equations and topological models for dynamical systems; by variously "joining the world of shapes to the world of numbers."

The generation of natural shapes from a simple set of rules with built-in randomness, repeated as much as one likes—or from randomness focusing itself by means of a few simple rules—has been for the metaphysically inclined the most intriguing aspect of the new science. All depends, of course, on what one sees. If one sees a universe grounded in fundamental chaos—randomness, unpredictability, indeterminacy—then the new science charts the "spontaneous emergence of self-organization." If one sees a universe grounded in fundamental order—causality, predictability, uniformity—then the new science shows "deterministic systems generating randomness." But perhaps one does not have to choose; randomness and recurrence give rise to rule, and rule, reflexively, organizes randomness.

Cosmos, in human experience, is what can be carved out of chaos and grasped, by modeling, by sorting and assorting, by explaining origins, by learning what to expect. Characteristically, the new science of chaos addresses transitions and boundary states: between regular flow and turbulence, between periodicity and unpredictability. It opens a whole new world, heretofore "invisible," of symmetries and homologies in nature. It offers a set of ideas and equations, and even a mathematical constant, that bring into a single conceptual space an extraordinary diversity of phenomena and disciplines.

In other words, the new science of chaos is a science because it makes inroads on real chaos and gives us a handle on the spoils. But as Satan discovered in Milton's *Paradise Lost*, Chaos, "a dark/Illimitable Ocean without bound," still remains, even after the subtraction of Heaven, Earth, and Hell. It remains illimitable and properly speaking unimaginable, a challenge stretching between the intrepid explorer and absolute Light.

—Martin Meisel

THE ELEMENTARY STRUCTURES OF POLITICAL LIFE: Rural Development in Pahlavi Iran
by Grace E. Goodell
Oxford, 1986
362 pp. $45

Beginning in 1972, Grace Goodell, an anthropologist now at Johns Hopkins University, spent some 20 months in the southwestern Iranian province of Khuzestan studying the impact on rural folk of one of Mohammad Reza Shah Pahlavi's most ambitious programs. The goal of the Shah's Khuzestan project was nothing less than large-scale, integrated agricultural and industrial development of an entire region.

Goodell carried out her study by living in two places, selected for the contrasts they offered. One, Rahmat Abad, was a village whose ways had been little disturbed. The other, Bizhan (both names were changed), was