chapters introduce relevant issues preceding the accident: the public debate about the acceptance of nuclear power, the evolution of the elaborate federal regulatory system, and a brief summary of the engineered defenses against reactor accidents and the various challenges to the adequacy of those defenses. The heart of the book is the next five chapters, which give a play-by-play account of the accident. The chapters each deal with one of five days during the crisis and are succinctly titled "Wednesday, March 28" through "Sunday, April 1." The final two chapters deal with the accident's immediate aftermath and long-term effects.

The book contains little technical information, and many of the technical explanations that do appear range from inadequate to misleading to incorrect. Innumerable existing published papers and documents would be much more useful to a physicist seeking technical information. The book is largely about the personal interactions among the plant's operating staff; the actions of the plant's owner, Metropolitan Edison Co, headquartered in New Jersey; and those of the designers of the nuclear steam supply system, Babcock & Wilcox Co, whose headquarters are in Virginia. But more important, Walker details what was going on behind the scenes involving NRC personnel at the site and in Washington, DC; the Pennsylvania government and White House officials, including President Jimmy Carter; the several hundred media reporters who roamed throughout the area, constantly filing stories; and the residents who lived near the site.

From 28 March to 1 April, news reports contained a serious dearth of information from often contradictory sources having varying degrees of credibility. This situation led to suspense and excitement; at different times, it suggested a wide variety of evacuation scenarios that ranged from no evacuation to pregnant women only to the whole population, including people at various distances. Misinterpretations by the media substantially added to the confusion. For example, the radiation level at the discharge point at the top of a tall air-discharge stack was reported as the radiation level on the ground in a populated area. The mismatch in communication between scientists, who habitually shy away from flat statements like "impossible" or "inevitable," and news reporters who wanted nothing but flat statements and who ignored phrases like "highly improbable," was a constant problem. At one point, the NRC chairman jokingly said to his fellow NRC commissioners, "Which amendment guarantees freedom of the press? I'm against it." His statement was widely reported and came back to haunt him.

Confusion about the accident was rampant. For instance, the possibility of a fire burning hydrogen gas was magnified by some scientists and reporters into a hydrogen explosion, which requires much higher concentrations of hydrogen, and was even interpreted by some media outlets as a nuclear hydrogen bomb. Information presented by technical experts as highly improbable, worst-case scenarios was again interpreted by some reporters as expected occurrences. The confusion extended to all levels—even the governor of Pennsylvania, who had to make decisions about evacuation, misinterpreted what he was told directly by the NRC chairman.

The five chapters that give a play-by-play account provide excellent reading for anyone interested in people's interactions with each other during a crisis. It is difficult to put Walker's book down in the midst of his exciting narrative; such literary momentum will surely motivate one to continue reading the final two chapters about how people dealt with the accident's aftermath.

Since *Three Mile Island* is a history book, the first three introductory chapters chilled me with the reminder that journalists write the first draft of history. A large fraction of the footnotes refer to newspaper and magazine stories. As is common practice in news outlets, initial reports based on very limited information are often discussed in great detail while the final resolution of the issue based on extensive solid information is ignored. For example, the book discusses at great length the controversy in the early 1970s over whether the emergency core cooling system was adequate. The debate was instigated by the system's apparent failure in small-scale, crude mock-up experiments. However, no mention is made of the very large-scale tests and related analytical studies that indisputably established the system's adequacy well before the TMI accident. Moreover, in following the practices of many journalists, the author attributes as much credibility to antinuclear activists as to experts in nuclear science and technology—even though the activists have little scientific or engineering education and have never published in scientific or technical journals.

Because it is a history book, *Three Mile Island* shows us that journalists not only write the first drafts of history but also heavily influence the final drafts.

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E. Coli in Motion

Howard C. Berg
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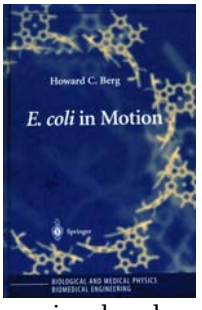

The barriers between traditional disciplines in science are beginning to disappear. Howard Berg's book *E. coli in Motion* presents a classic example of interdisciplinary research at the interface between biology and physics, from 17th-century microscopy through major breakthroughs in the 1970s and 1980s, and up to the present.

The book focuses on *Escherichia coli*, probably the best understood of all organisms and the source of much of our current knowledge about genetics and molecular biology. *E. coli* is just about the simplest organism that displays behavior complex enough to be worth studying. As Berg reveals, the behavioral repertoire of this tiny bacterium is remarkably wide for a bag of chemicals only a few microns long and about 2×10^{-15} kg. The story of how *E. coli*'s behavior can be understood at a molecular level is a fascinating one in itself. It is also a useful example for researchers in such areas as neuroscience and systems biology who are beginning to attempt to reach the same level of understanding of more complex living systems.

Berg's book is well written and accessible yet densely packed with information and insight. In writing a concise and accurate account of the book's purpose and contents, I'm unlikely to do a better job than Berg did in his three-page epilogue. As one of the founders of the modern field of bacterial chemotaxis and an eminent figure in the world of biological physics, the author writes with authority. He presents *E. coli* not as the faceless biochemical factory familiar to geneticists and molecular biologists, but as an individual swimming around looking for food, making decisions, and trying to get along in the world. Often he invites the reader to "step . . . into *E. coli*'s shoes," and he shows obvious affection for his tiny protagonist and for the process of scientific discovery. Yet,

at the same time, the book gives a rigorous and essentially complete account of the field while touching on several relevant topics in molecular biology, physics, and biophysics.

The story begins in 1676 with Antony van Leeuwenhoek's fascination at what he saw swimming around under his microscope. It proceeds into the modern era with detailed measurements of the behavior of swimming bacteria, as populations and as individuals, and ends with an account of a marvel of biological nanotechnology: the bacterial flagellar motor, nature's most sophisticated rotary electrical motor. Along the way, Berg reveals the molecular signaling network that allows *E. coli* to sense its environment and to navigate, propelled by its flagellar motor, using a strategy that has been optimized over evolutionary eons.

E. coli in Motion is slim, and its short chapters are further divided into sections that are seldom more than a few pages long. Its style is concise and to the point. It brings simplicity and clarity in plain English to subject matter that might otherwise be complicated and difficult. The book is not short of colorful illustrations. For example, Berg writes that "the neocortex in humans is a multilayered sheet of cells, about 1 millimeter (mm) thick, almost large enough to cover your desk top." And although the book draws links to other fields where appropriate, it is never wordy and never strays far from the central theme. Most technical terms are explained for the layperson, and Berg describes basic biology and physics that might have been assumed knowledge in a purely academic text. The conflicting demands of thoroughness and brevity occasionally lead to bare statements of fact (but always accompanied by references) that might leave the layperson none the wiser. Berg makes little attempt to woo the reader, preferring to lay out the facts and let them speak for themselves. This may be a deliberate challenge, expressed in the last sentence of the book: "Curiosity is the driving force of basic science."

E. coli in Motion should appeal to a variety of readers. It is an excellently written and entertaining story of modern interdisciplinary science, full of information and without hype or wild speculation. For the specialist, it is a mine of information. But perhaps most of all, the book is a case study for anyone interested in the field of quantitative life science. I most heartily recommend it to any mathematician, physical scientist, engineer, or biologist who wants to learn more about what physics and biology can do for each other.

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Modeling Complex Systems

Nino Boccara
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Complex systems are ones with many strongly interdependent variables. This definition excludes systems with only a few effective variables, the kind found in elementary dynamics. It also excludes systems with many independent variables, the sort students learn to deal with in elementary statistical mechanics. Complexity appears where coupling is important—but doesn't freeze out most degrees of freedom.

Under the heading of complexity, physics journals now routinely publish papers on animal populations, botanical invasions, cardiac arrest, developmental biology, evolutionary games, finance, gene regulation,