BOOKS

Pushing Physics to (and over?) the Edge

When Things Start to Think

Neil Gershenfeld
Henry Holt, New York, 1999.
225 pp. $25.00 hc
ISBN 0-8050-5874-5

The Nature of Mathematical Modeling

Neil Gershenfeld
Cambridge U. P., New York, 1999.
344 pp. $39.95 hc
ISBN 0-521-57095-6

Reviewed by Michael Marder

In 1995, Neil Gershenfeld wrote an Opinion piece in PHYSICS TODAY entitled "Why I Am/Am Not a Physicist" (July, page 50), in which he discussed the subject of physics tomorrow. He argued that the conventional domain of physics is too restrictive, but that physics training has a crucial role to play as computers become embedded in both everyday life and the practice of scientific research. He has extended this line of argument into booklength form—and not one book but three. Two of the books are reviewed here; the third, *The Physics of Information Technology*, is not yet available. The first two books at first seem completely unrelated. One is a quick read without mathematics, aimed at a popular audience, and appears to be selling at a reasonable clip. The second is a graduate-level text. Yet both aim to carve out by example a new role for physics, and it is an interesting one.

The popularization, *When Things Start to Think*, provides a mixture of sensible skepticism about the technology of today, breathless enthusiasm for the technology of tomorrow, and scientific autobiography. That is, it describes some upcoming technologies in the development of which Gershenfeld is playing a role, and he explains why they are so much better than what we have now. These technologies range from electronic newspapers (that download automatically each morning into a flexible display device that imitates newsprint) to new forms of electronic money to quantum computing.

The view of the future is a bit cheerful for my taste. One chapter is devoted to the Personal Fabricator, an advanced descendant of the laser printer that will build complex, three-dimensional machines. Prototypes already exist, but the prospect of a Fab for every home is a little unsettling. I do not really want to manufacture my own Mazda camshafts and install them in the comfort of my garage. And I *really* do not want my twelve-year-old downloading designs for an antipersonnel mine and building one in the comfort of my living room.

The book has strengths and weaknesses, because it is so closely connected to personal experience. The discussions of the projects on which Gershenfeld has worked are all entertaining and full of details that only the central figures could know. The creation of an electronic cello for Yo-Yo Ma is described in detail; some sort of bizarre howling seat, built for the inimitable magicians Penn and Teller, morphs into a practical car safety device, in a completely improbable sequence that could happen only in real life. Yet at times the tight focus on the MIT Media Lab, where Gershenfeld works, is a bit annoying. It gives the impression that no work is being done on pervasive computers, electronic ink, or fabricators anywhere else. Almost the only person outside of MIT to receive mention is Richard Feynman (whose name is consistently misspelled).

The book closes with a series of commentaries on education and on ways for stodgy academic institutions to contribute more vigorously to the high-tech society that increasingly treats physics as a relic. There is a great deal of unconventional wisdom in these chapters, and they are worth reading.

In *The Nature of Mathematical Modeling*, Gershenfeld lays out a graduate course on techniques for describing and modeling data. Only a small fraction of the topics he covers would normally be considered physics, and he draws equally from engineering mechanics and mathematical statistics. But the style of the book is recognizable as physics. The main text is quite short, moves very quickly, and covers a great deal of ground. The mode of operation is to carry out brief computations leading to useful results and to state all theorems without proof. Even when engaging in a preposterous task, such as covering much of classical mechanics in ten pages, the text remains quite readable. Some of the material was unfamiliar to me, and I was pleased to find that I was able to learn from it fairly easily, despite the great condensation, because of Gershenfeld's consistent effort to emphasize the purpose and merit of each calculation.

The text is divided into three parts. The first is a very rapid review of analytical techniques for linear equations, moving too fast even to mention details such as boundary conditions. The second part discusses numerical methods, mainly brief surveys of finite-difference and finite-element methods, with an excursion into lattice gases. The third and longest part of the book applies these complementary methods to the analysis and modeling of sequences of data, particularly time series. Having the contributions of many different communities to this problem assembled and compared is unique and valuable.

Some things are missing: The Web site that is supposed to contain sample projects is still empty as I write; there is little mention of the analysis of spatial as opposed to temporal patterns; and actual physical systems rarely emerge from behind the mathematics. However, I do not know any other single source of the material presented here.

But is it physics? Not really. Gershenfeld is presenting a vision of education in which fields such as physics, applied mathematics, computer science, and electrical and mechanical engineering merge and blend in new ways, responsive more to challenging problems than to tradition. If physicists still have a chance to take the lead in this redefinition of boundaries, we should grab it while we can.

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Cradle of Life: The Discovery of Earth's Earliest Fossils

J. William Schopf
Princeton U. P., Princeton, N.J., 1999. 367 pp. $29.95 hc
ISBN 0-691-00230-4

What a curious book! Or books, rather, for J. William Schopf's *Cradle of Life* seems not quite to know what it is trying to be. Summertime science read, historical treatise, personal memoir, microbiology textbook, dia-