Nanotech! What is it? The term *nano* (as used in such compounds as *nanoscience* and *nanotechnology*), once an obscure adjective found primarily in discussions of electronics, has come in recent years to be identified with exciting discoveries in the physical sciences. The proponents of nanosresearch have ranged from thoughtful, conservative scientists to the most ardent of enthusiasts, and the claims for it have ranged accordingly.

Most new areas of study start life swaddled in optimism; but at a certain point in their adolescence, it is important to have some sense of whether their promise to change the way we think and live will ever become reality. It is still not clear what nanoscience will grow up to be. Two recent books—*The Dance of Molecules*, by Ted Sargent, and *Nano-Hype*, by David Berube—are, in different ways, efforts to explain the field to outsiders.

*The Dance of Molecules* is the ideal book for your favorite science-infatuated high-school-age niece—someone in love with the potential of science, someone who wants to be amazed and excited, someone who is not too concerned with such picky adjectives as "accurate" or "realistic." In contrast, *Nano-Hype* is for those who would really like to know the history of nanoscience and nanotechnology, to understand the social structure of the discipline and to think about how it is communicated. Author David Berube asks, not "What is nano?," but "How did this field so flourish and attract so much attention, whereas others that started with equal promise, and in equal obscurity, have remained safely cloaked in that obscurity? Who pays for this research, and why? What kinds of people and businesses are promoting it, and for what ends? How does public policy deal with it?" Neither book is intended to be a hard-nosed, technically detailed assessment of current nanoscience and nanotechnology or of the economic opportunity and social cost and benefit of the activities that fall under "nano" headings.

*The Dance of Molecules* is a kind of tone poem, a paean to the idea of the limitless wonders of technology. It is organized into chapters with titles intended to catch the attention of the general-science reader: "Diagnose," "Heal," "Grow," "Energize," "Protect," "Compute," "Humanize." Although its subtitle is "How Nanotechnology Is Changing Our Lives," it mixes what nanoscientists would agree falls in the domain of "nano" with subjects—chemistry and materials science and biotechnology—in which the application of a conventional definition of *nano* is sometimes a stretch. The book is a collection of vignettes describing areas of science that have still-unrealized ambitions to become technologies. It focuses on potential applications, some real and some far-fetched: an electronic "dog's nose" to sniff explosives, "quantum corrals" showing ripples in an underlying electron sea, molecular beacons and quantum dots illuminating the machinery of the cell, liposomes for delivery of anticancer drugs, stem cells for what ails you, solar cells and conducting polymers to generate and transport energy and information. All these wonders are there, and much more.

A smorgasbord of subjects is a fine strategy for this kind of book: What counts are a sense of excitement and examples of what might be opportunities for a new field of science and technology. The academic questions of what departments in universities should house the researchers and of how their funding and oversight should be arranged, and the small technical details of probability of success and what size really qualifies for the label *nano* are not very relevant if the objective is to convey a sense of why science is so engaged with small things. I personally do not think that many of the ideas that are so enthusiastically sketched in the book will ever become significant technologies, but that is opinion.

Sargent is associated with MIT, and *The Dance of Molecules* has something of the quality of a photo album from a research-group picnic: "These are my friends, and let me tell you what they are doing and how cool they are." That's fine: *There is cool stuff done at MIT.* That parochialism notwithstanding, this book is very well written for a general-science audience—much of it is...
lovely, transparent prose, employing engaging
and quirky analogies and displaying a real grace
in choice of words. "The year Greta Garbo died of
kidney failure in New York was the year I made
up my mind to become a nanotechnologist," it
begins, and then sweeps the reader along on a
roller coaster constructed of mixtures of fact and
fantasy. The book is entertaining and very easy
to read. It conveys a real sense of the range of
the subject and of the enthusiasm of its practitioners.
The author’s evident love for the research he is
writing about illuminates the book.

The nanohyperbole meter runs from nano-
panic to nanopanacea: If −10 is one end of the
scale ("Nanobots and the ‘assembler’ are the end
of humankind as a species and, indeed, of life on
Earth”) and +10 the other ("‘NanO’ is the next
turn of the great wheel of technology that pow-
ers civilization—akin to the discovery of fire, the
integrated circuit or carbonated soft drinks"), I
would rank this book at about +7. Still, its tone is
not so much hyperbolic as optimistic: Something
important might come from these activities, if one
waits long enough and is not too fussy about trac-
ing where the ultimate good ideas originated.

Nano-Hype is a more sober and scholarly work.
For the most part, it is a useful, evenhanded, de-
tailed history of the development of nanoscience,
as viewed through the eyes of a social scientist.
Berube clearly has followed the field from its be-
inning and has paid close attention to its details
as they have appeared. The book is extensively
documented; it offers the most encyclopedic ac-
count of the development of nanoscience and
technology that I know. I am certain that it will
be mined for references by generations of future
graduate students in the sociology and history
of science. Its prose is clear, if proxil, and better at
conveying information than excitement.

Exhaustively documented history can some-
times be a little tedious, and, perhaps to avoid this
quality and to add color, the book seems to have
had one (or several) human-interest stories grated
onto its scholarly trunk. These grafts have not
quite taken. The sections that focus on “hype” tend
(at least from the vantage of someone working in
the vineyards of nanotechnology) to overstate is-
suies, and the squabbles between Eric Drexler and
reactionary establishment science (the late Rick
Smalley and I are taken as representatives of this
group) are given a weight that they did not have
from inside the squabble. Issues in ethics and risk
in nanotechnology simply are not as serious and
immediate as those, for example, in biotechnology
or nuclear weapons or global climate change.

As a scientist, I was particularly interested in the
light shed on “nano” by the social sciences. It is a
very different spectrum of frequencies! “My goal is
to provide the reader with a better understanding
of how nanotechnology has been communicated
to the many audiences willing . . . to listen,” Berube
explains. Later he notes that “Nanotechnology is
another in a long list of media- and government-

457 UNKNOWN QUANTITY: A Real and Imaginary History of Algebra. By John Derbyshire. Reviewed by Judith V. Grabiner. An amusing, but too often misleading, account of the basic algebraic ideas and the historical relations among them

472 BEFORE THE DAWN: Recovering the Lost History of Our Ancestors. By Nicholas Wade. Reviewed by Craig Stanford. An overview of what we know about the record of ancestry and ethnicity that stretches from us back to the people of the Neolithic

474 MOUNTAINS FROM SPACE: Peaks and Ranges of the Seven Continents. By Stefan Dech, Reinhold Messner, Rüdiger Glaser and Rolf-Peter Martin. Reviewed by Fred T. Mackenzie. This coffee-table book with outstanding satellite imagery shows why the Earth’s largest mountain ranges have long fascinated humankind

476 NANOVIEWS. Short takes on three books: Condor • Organic, Inc. • Aglow in the Dark

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sanctioned fears." The chapters are primarily oriented toward processes: "Speculation and Criticism about Nanotechnology," "Government Actors in Nanotechnology," "Government Initiatives in Nanotechnology," "Promotional Reports on Nanotechnology," "Nanotechnology and Nano-Entrepreneurs," "Nongovernmental Organizations and Nano." There are chapters on technical and ethical issues—"Nanohazards and Nanotoxicology," "Applications of Nanoscience," "Societal and Ethical Implications of Nanotechnology Research"—but these also tend to focus more on the processes used to explore these subjects than on the outcomes of those processes. So, the focus of the book is less on "nano" per se, and more on how "nano" is perceived, discussed, paid for, regulated and promoted. These issues are interesting and important ones, and reading NanoHype will give anyone who wishes to understand the societal machinery that supports scientific research a most useful education.

In defining "hyperbole," Berube quotes Boston University linguist Bruce Fraser: "Hyperbole involves the conveying of a proposition that so distorts the obvious truth that the hearer recognizes the non-literal intention on the speaker's part." Berube continues by pointing out that hyperbole can be hard to recognize, and he notes that "Misunderstanding predicated on the improper decoding of hyperbole is not all bad." Probably true, but in science, "hype" has come to mean (my definition) "uncritical claims for unrealizable potential, sometimes for reasons that are self-serving, sometimes through an excess of enthusiasm, and sometimes simply through error or misunderstanding of the science or the problem." Berube's book serves, among other valuable purposes, as a kind of Rosetta stone: Read it, and perhaps—as a scientist—you might begin to understand how someone interested in communication thinks about science. It's a useful and important thing to learn.

Nanoscience and nanotechnology are in a phase of high activity, high growth and more than a little exaggeration. Sargent gives a romantic, pointillist introduction to the subject; stand back far enough from the details of his vignettes, and an impressionist painting of current research emerges. Berube describes the paint, the paint brushes, the canvas, the frame and the easel. Both perspectives are important. Neither book really focuses on the subjects that, to me, are the most interesting, large-scale issues associated with "nano": the ability of evolutionary nanotechnology that is already rapidly developing in the electronics industry to make the storage of information effectively free, and the uses and abuses (for example, the erosion of privacy) of that capability; the opportunity for nanengineered catalysts and materials in global-scale production of energy; the importance of nanoscale particles and colloids in areas of science ranging from modeling global climate to studies of the origin of life. But then, Sargent and Berube may be right and I may be wrong; it's too early to tell.

Much of the history of science, as recounted by scientists, is revisionist. A random walk across ideas and experiments—false starts and stops, flimsy justifications that are abandoned and replaced by better ideas, extraordinary technologies grown from ordinary science almost by accident—is usually tidied up into a well-planned straight line. These two books are both witnesses to the real, chaotic, messy process of developing new technologies. Both are well worth reading, although by different audiences and for different reasons.

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