Cyberscience

William H. Press

Supercomputing and the Transformation of Science. By William J. Kaufmann and Larry L. Smarr. W. H. Freeman (Scientific American Books): 1993. Pp. 238. £18.95, \$32.95.

In their preface, Kaufmann (who has previously written several excellent books) and Smarr (an astrophysicist who now directs the National Center for Supercomputing Applications in Illinois) invoke the image of a global 'cyberspace', a construct of pure information, parallel to, but distinct from, physical reality. Increasingly, we are seeing all sorts of societal activities migrate into cyberspace. The financial sector's move is almost entire. Entertainment and the arts are beginning the transition, not only with digital storage and transmission media (compact disks, high-definition television), but also with the creation of purely computational art, ranging from computer music to the popular 'morphing' of film images.

The intersection of cyberspace with science, variously called computational science, simulation science or (as these authors term it) supercomputing, is a world where physical laws are known or posited, as in theoretical science, but where complex physical systems can be seen (within the computer) evolving in their own only partially controlled manner, very much as in an experimental or observational science. Supercomputing, according to the authors, is not just faster computing. It is marked by the crossing of a distinct threshold in the complexity and realism with which systems of interest are modelled, an abandoning of the simplify-and-idealize tenets of theoretical science in favour of a much richer (though, to some, less pristinely elegant) framework.

A trivial, and at the same time profound, corollary is that the results of supercomputing cannot usefully be displayed as graphs or tables of numbers. Computational science requires, and uses, the most advanced computational techniques of colour graphics, computer visualization and animation. (As part of the Scientific American Library series, this book is lavishly illustrated in full colour. Alas, no accompanying video!)

The first third of the book (three chapters) is an ambitious and generally successful attempt to explain, at a level appropriate to the educated nonscientist, how computational science works, specifically how the continuum (or quantum mechanical) equations that describe physical reality can be accurately approximated by discrete computational techniques such as finite difference, fi-

nite element, Monte Carlo or N-body particle models. The rest of the book surveys the different scientific disciplines and highlights specific projects, mostly work done in the United States at one or another of the national computer centres sponsored by the National Science Foundation. Topics include quark phase transitions, fullerenes, quantum-well devices, chemical kinetics, protein folding, blood flow, brain function, casting and rolling steel, automobile crash testing, mantle convection, ocean circulation, weather and climate prediction, turbulence, astrophysical jets, black holes and large-scale cosmological structure.

Like the rest of the Scientific American Library series, the book is nominally addressed to the adult reader. Notwithstanding, it is an ideal volume for a bright 12–14-year-old, especially one who is (or shows signs of being) addicted to computers. Scientists and science educators might do well to worry about the attractiveness of computers and the sense of power they unlock for brilliant young people today. We in the 'traditional' sciences are perhaps losing too many of the best young minds to in-

terests and careers in computer science and other information technologies.

Most of us can name a few particular books, read in pre-college years, that influenced our choice of science as a life's work. The best of these often give a sense of both the science and the doing of science. The younger reader is thus able to get some kind of tentative vision of what his or her own life in science might be. A senior generation of scientists was influenced by Paul De Kruif's *Microbe Hunters* (1926) or Sir James Jeans's *The Universe Around Us* (1929). I recall with pleasure Jane Werner Watson's *The World of Science* (1958), along with the delightful books of George Gamow. In recent years, the books of Paul Davies have inspired many.

Kaufmann and Smarr's book could (one might say, should) be similarly influential to the present generation of youthful computer enthusiasts. Like the books mentioned above, its specific content will be superseded in a few years; but in the meantime the book may be able to rescue some future Nobel laureates from becoming otherwise lost in cyberspace. That is one point of view; another is that these future Nobel laureates may in fact earn their prizes by bringing more supercomputing to science, and thus moving more of science into cyberspace. □

William H. Press is at the Harvard-Smithsonian Center for Astrophysics, Harvard University, 60 Garden Street, Cambridge, Massachusetts 02138, USA.

Good posture

The traditional (below) and more recently proposed (right) stance of carnosaurs, here *Tyrannosaurus rex*, both based on the posture of birds. There is still, however, no consensus regarding the stance of these dinosaurs.

The drawings are taken from *The Dinosauria* edited by D. B. Weishampel, P. Dodson and H. Osmólska, a comprehensive compendium of information on dinosaur anatomy, taxonomy, diversity and distribution. For a review, see *Nature* 348, 686; 1990. University of California Press, \$47.50, £27.50 (pbk).