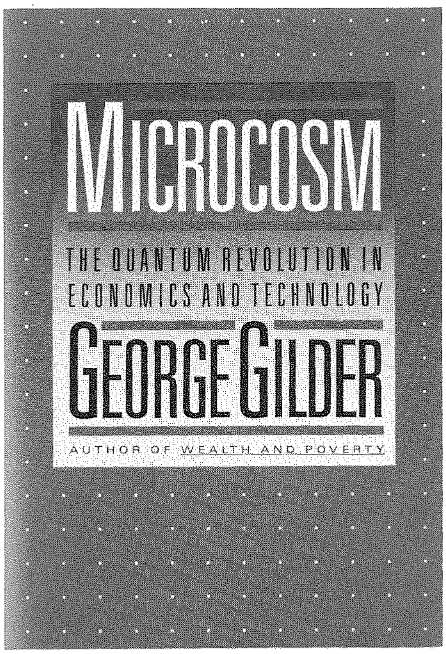
Books



Simon and Schuster, 1989
$19.95
426 pages

George Gilder, supply-side economist and author of the best-selling *Wealth and Poverty* and of *Spirit of Enterprise*, is a provocative thinker and entertaining writer who also understands technology. In his latest book, *Microcosm: The Quantum Revolution in Economics and Technology*, Gilder presents an inside view of the history of the semiconductor industry to support his thesis that fundamental but largely unrecognized changes have occurred in the world economy. This new scientific materialism dictates that a nation's wealth and consequent standard of living depend less on its natural resources and manufacturing skills than on its ability to handle information and foster innovation.

Where should we seek this new source of wealth? Gilder argues that we must look within the microcosm, the domain ruled by quanta and lying beyond human senses and common experience. The microcosm is not only where scientific understanding begins, but is also the frontier of technology in the information age. Integrated circuits and the information-handling structures of life dwell in the microcosm because the storage, processing, and communication of information are cheaper and faster in a world of smaller dimensions and energies. The "overthrow of matter" by quantum theory was the precursor to the microelectronic chips that have made possible today's proliferation of low-cost, high-performance computing and communication systems. These machines exist to manipulate information rather than matter or energy; have no moving parts, friction, or wear; and are constructed principally of silicon, oxygen, and aluminum, the most abundant elements in the earth's crust.

Gilder's premise that economic power today flows principally from information rather than material resources leads in several steps to the implication that, to be successful, economies must be guided by the principles of the microcosm. As Gilder states so eloquently in his opening chapter:

> Today, the ascendant nations and corporations are masters not of land and material resources but of ideas and technologies. Japan and other barren Asian islands have become the world's fastest-growing economies. Electronics is the world's fastest-growing major industry. Computer software, a pure product of mind, is the chief source of added value in world commerce. The global network of telecommunications carries more valuable goods than all the world's supertankers. Today, wealth comes not to the rulers of slave labor but to the liberators of human creativity, not to the conquerors of land but to the emancipators of mind.

Those areas of information technology that create the largest added value belong, according to Gilder, to free-market economies. The United States has long been the world leader in information technology, and will extend that lead not by pursuing routine and capital-intensive high-definition-TV and memory-chip manufacturing, but by creating the programming and software that will make them useful.

The reactions in the national press to *Microcosm* focus predictably on Gilder's economic thesis and its meaning to competition in microelectronics with Japan. Caltech readers will be at least equally interested in the inside story of the semiconductor industry and the fascinating glimpses of the personalities who have pioneered its development, including many who are Caltech alumni, faculty, and students. Gilder's accounts often go well beyond a person's influence on and contributions to microelectronics to describe working habits, backgrounds, and personal lives. It was certainly not Gilder's plan to write a complete history of the semiconductor industry; rather, he has concentrated on the pivotal innovations that have shaped this industry.

Caltech's Carver Mead, upon whom Gilder bestows the title of "prophet of the microcosm," is the hero of this story. The title of "prophet" is well justified by Mead's early work with tunneling devices; his characterization of Schottkybarrier devices built from a variety of III-V materials; his theoretical predictions with his graduate student, Bruce Hoeneisen, of the limits of scaling of silicon metal-oxide-semiconductor field-effect transistors; his contributions to design methods for high-complexity microchips, such as microprocessors; his pioneering development with his graduate student, David Johannsen, of silicon compilers; and his most recent efforts with high-complexity, biologically inspired analog chips. Many other Caltech people enter the story as Mead's teachers, students, friends, and co-workers, including Max Delbrück, Richard Feynman, John Hopfield, Misha Mahowald, Amr Mohsen, Linus Pauling, Ivan Sutherland, and John Wawrzynek.

Carver Mead is the Gordon and Betty Moore Professor of Computer Science at Caltech; Gordon Moore is a Caltech alumnus and trustee who plays another prominent role in Gilder's accounts as co-founder of Intel Corporation, the company that pioneered the dynamic memory chip, the electrically programmable read-only memory, and the microprocessor. Technical developments such as these, as well as later developments in silicon compilation, analog circuits, and neural computers, are described accurately, but in a style that will be readily understood by people outside of the fields of computing and microelectronics. *Microcosm's* extensive bibliographical notes are interesting reading in themselves, and refer the reader to an eclectic but well-selected collection of related writings.

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