PROFILE

For Leon Cooper, biology and technology are merging

BY MARK WILLIAMS

ON AN October evening in 1972, Leon Cooper's wife came to Brown University to drive him home while his Camaro convertible was being repaired. When she arrived, she told him that a Swedish radio reporter had just called their house. The man in Stockholm wouldn't explain what he wanted, she said, only that he'd phone again in an hour. It was close to midnight, however—after the Coopers had consumed dinner and several glasses of scotch—when the reporter called back and confirmed that the Nobel Prize in physics had been awarded jointly to Mr. Cooper, John Bardeen, and Robert Schlieffer, for the theory of superconductivity that the three physicists had proposed in 1957.

So, amid the whirl of publicity in the months before his Nobel lecture, Mr. Cooper had to get reacquainted with superconductivity. Since the late '60s he had been trying to understand how biological nervous systems worked, and to build artificial systems with similar capacities for learning and remembering.

SPEAK, MEMORY

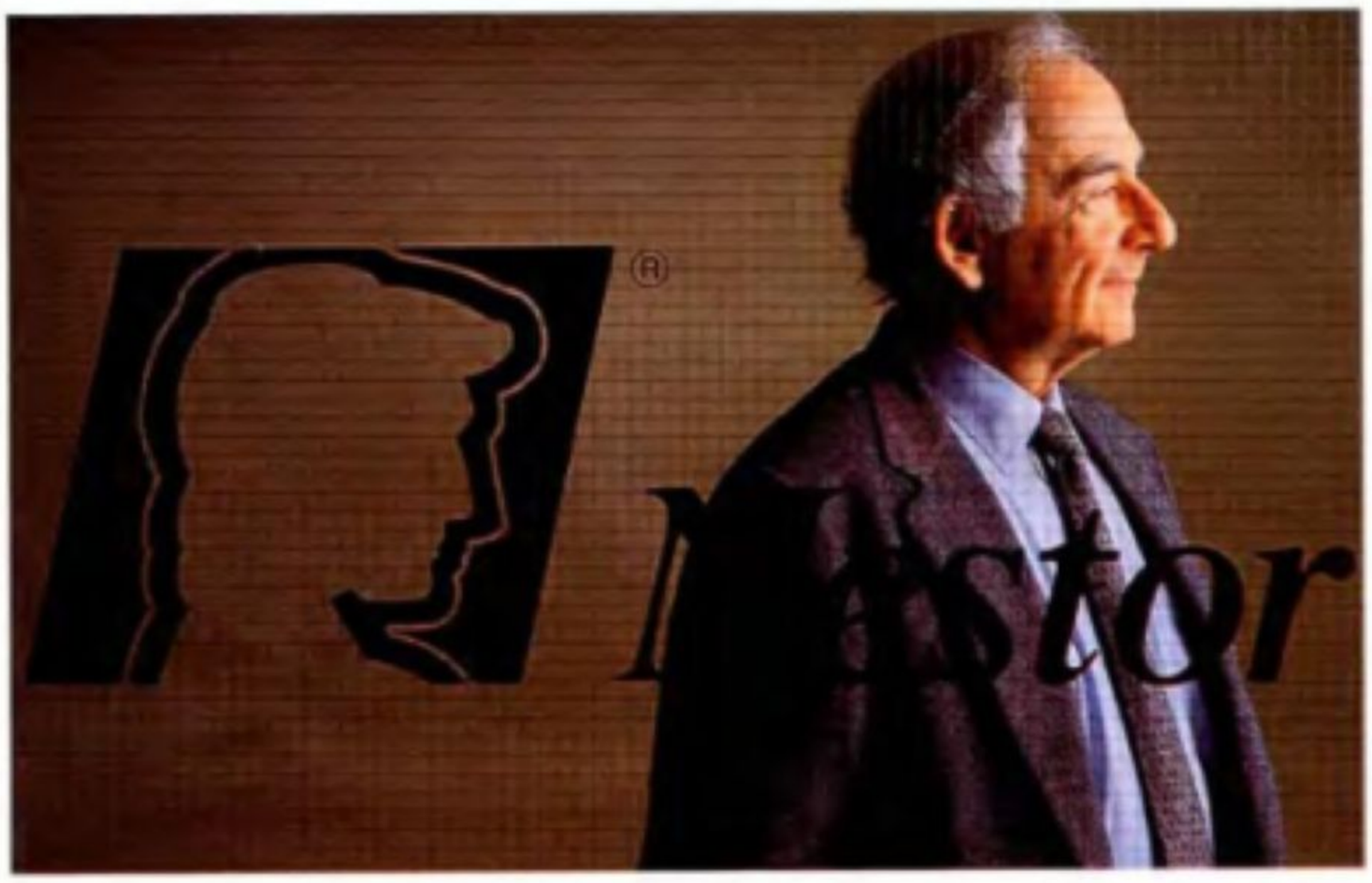
His cross-disciplinary transition, Mr. Cooper insists, was gradual. As a teenager at the Bronx High School of Science, he'd won the then-prestigious Westinghouse Science Talent Search with a biology experiment, enabling him to enter Columbia University in 1947. Figuring that only while young would he be fully able to absorb "the deep mysteries" of relativity and quantum theory, he majored in physics. When his interest in the electrons' interactions that produced superconductivity in metals lessened, he recalled his old fascination with biological problems. Trying to understand how memory was stored and how thinking happened, he decided, definitely would satisfy his predilection for deep mysteries.

"I knew about many-body problems," he explains. Superconductivity had been such a problem, whose solution began to emerge when Mr. Cooper analyzed what scientists already knew about the many different interactions among electrons. Physiology textbooks indicated to him that the properties of individual neurons were also quite well known, yet nobody had any idea how minds and memory arose. So, he speculated, mental processes might analogously be a many-neuron problem. This proved false. "But it got me going," he says.

BRAINSTORM TROOPER

Since 1974, Mr. Cooper has been the Thomas J. Watson Sr. Professor of Science at Brown University and the director of Brown's Institute for Brain and Neural Systems since its founding in 1973. Commencing with investigations of how visual-cortex cells are modified as they detect the external world's features, over the years Mr. Cooper has—singly and with colleagues—advanced scientific understanding of the biophysics of cell-to-cell signaling in neuroplasticity (which most of us call learning). Besides studying the molecular basis for how our brains do what they do, he and his colleagues have worked toward understanding the larger architectures that create functions like memory. Furthermore, from the beginning they've tried to model these architectures in artificial systems that, whether hardware or software, are known as neural networks.

"Of course, in the early days," Mr.



JOHN FORASTE

MIND OVER MATTER: Mr. Cooper postulates reasoning machines.

Cooper chuckles, "there was nothing like the technology available now." Still, it was evident that, while computers could execute long sets of instructions with blinding rapidity, they couldn't perform the processes of generalization, association, and pattern recognition that humans manage easily. If one could duplicate such biological capacities, Mr. Cooper reckoned, one would have "the machines of the future." Moreover, the Institute was coming up with things that clearly had commercial applications. In 1973, with three other partners, Mr. Cooper founded Nestor, the first neural network company; it went public in 1983 (Nasdaq: NEST).

Collaboration with Intel produced the Ni1000 chip in 1995. With 1,024 processor equivalents of neurons to enable on-chip learning, the Ni1000 was a step forward in massively parallel hardware systems. Nestor also markets the PCI4000 Recognition Acceleration Board, with the Ni1000 chip on board to bring neural-network technology and supercomputer performance to PCs and workstations using PCI local bus architecture. Today, the company's products appear to be succeeding in the larger marketplace. Its Prism system, for example, helps banks recognize the anomalous patterns generated by fraud.

In the near future, Mr. Cooper believes, neural nets will become accepted as simply "part of the engineering toolbox." Later, as the technology evolves, truly intelligent machines will appear. Human beings, he points out, have long used machines to enhance their abilities. Only human self-centeredness, he suggests, has made us believe the universe's complexity is scaled to our intellects. Although there are scientific problems humanity finds important and solvable by human-sized minds, it's presumable that a great range of problems exist that are beyond our unaided powers. So—just as we have become comfortable with technology that can enhance our arms and legs or, more recently, with information technology that can enhance our logic and memory—people will get used to reasoning machines.

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Yet a machine that reasons still isn't a conscious machine. Mr. Cooper paraphrases the philosopher Satayana: "All our sorrow is real, but the atoms of which we are made are indifferent." There, he says, is the deepest mystery. Impatiently, he dismisses as evasions various theories that solving this mystery may be impossible or irrelevant. We cannot assume that a satisfactory reduction of how mental states arise from matter is impossible until we have properly attempted one, he contends, for even failure would be one of the most profound things we could learn about ourselves.

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