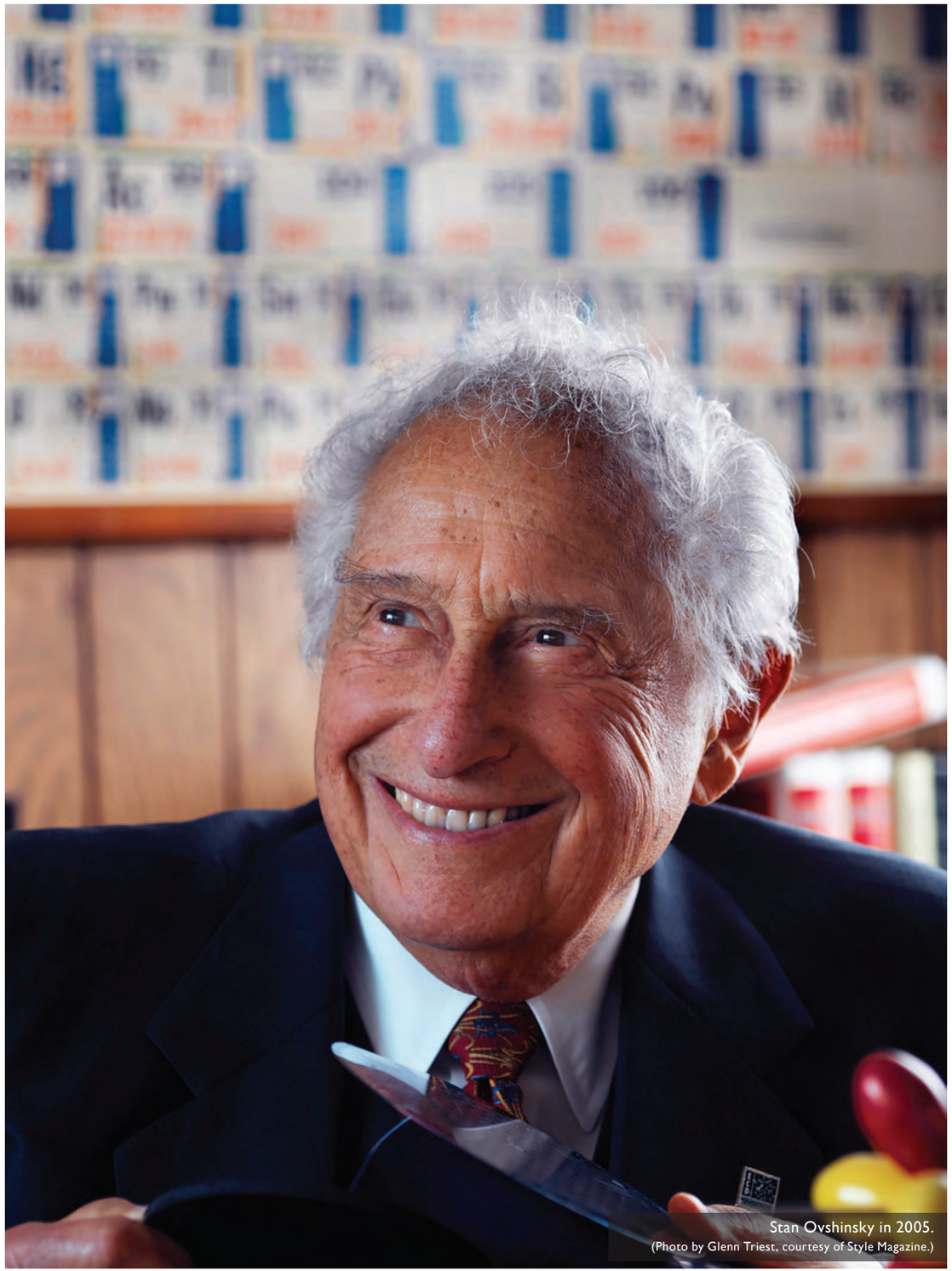

Stan Ovshinsky in 2005.
(Photo by Glenn Triest, courtesy of Style Magazine.)

BIOGRAPHY

The Legacy of Stanford Ovshinsky

By Lillian Hoddeson and Peter Garrett

Stanford R. Ovshinsky's name isn't as well known as it should be, though readers of the Berkeley Review of Latin American Studies have already learned something about his work. Yet even if his name still isn't widely known, Ovshinsky's energy and information inventions have become familiar parts of contemporary life. Leading examples include nickel–metal hydride batteries (the basis of many hybrid cars), thin-film solar panels, rewritable CDs and DVDs, and phase-change memory (the basis for the latest advance in computer technology). Almost as remarkable as these achievements are the social motivations behind Ovshinsky's work, particularly his early commitment to clean energy technologies, and the fact that he accomplished so much without any formal education past high school.

We have recently told the story of this extraordinary man in our biography *The Man Who Saw Tomorrow: The Life and Inventions of Stanford R. Ovshinsky* (MIT Press, April 2018). In this article, we want to step back and consider his lasting significance. Ovshinsky's technological innovations and scientific discoveries may recede in time as others build on and replace them, but the larger meaning we can find in his career will remain. We explore this meaning under three closely related aspects: his position as a scientific outsider, his unique historical trajectory, and his guiding progressive values.

The Outsider

The pivotal achievement of Ovshinsky's career as an independent inventor was a fundamental scientific discovery he made in 1961 while working alone in a modest storefront in Detroit, Michigan: a fast, reversible switching effect in certain amorphous (i.e., non-crystalline) materials, which became the basis for creating new semiconductor devices, like his threshold switch and phase-change memory. Ovshinsky's announcement of his discovery in 1968 sent shock waves through the field of solid-state physics because it described something previously considered impossible (at that time, the field considered only crystalline materials). Many physicists were outraged, not only because the discovery contradicted their assumptions, but also because it came from a scientific outsider, a self-educated former machinist, with no academic credentials beyond a high school diploma. What we now know as the "Ovshinsky effect" eventually became accepted, but it is important to recognize that he made his discovery not just in spite of, but because of being an outsider.

A quick review of Ovshinsky's early career indicates how his diverse experiences contributed to his discovery. He began working as a machinist and toolmaker in 1941 and by 1946 had made his first significant invention, a high-speed automated lathe that outperformed all others. He went on to develop other uses of automation, applying the principles of the new science of cybernetics to automotive inventions like power steering. Those principles considered control and communication in both animals and machines in terms of the same processes, like feedback, a parallel that led Ovshinsky to study neurology. Although he never held an academic position, he not only wrote and published papers in the field, but also carried out laboratory research on motor control. Then, based on his conception of the neuron, he created

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In a converted barn, Stan Ovshinsky (third from left) and his crew pose with his newly invented Benjamin Automatic Lathe in 1946.

Photo courtesy of Peter Garrett and Lillian Hoddeson.

a novel kind of electrochemical switch that he called "the Ovitron." This invention, which he described as his "nerve cell analogy," was clearly the work of an outsider. Neither a trained neuroscientist nor an electrical engineer would have been likely to arrive at the Ovitron.

Ovshinsky planned to develop the Ovitron further, but the settlement terms of a lawsuit with a former partner prevented him from using the same materials or design. Overcoming that restriction eventually led to his breakthrough switching discovery. Systematic experimentation and a series of hunches enabled him to replace the Ovitron's materials with the thin films of amorphous and disordered materials that produced the Ovshinsky effect. Several of those hunches drew on his working-class background, including his experience working at B.F. Goodrich, where he encountered thin films of dirt on the relays of lathes and milling machines and learned about the polymeric structure of rubber. Ovshinsky often proceeded intuitively, using analogies and visualization instead of the mathematically formalized methods of physics. In such ways, Ovshinsky's position as a scientific outsider enabled him to create the amorphous semiconductors that academically trained physicists could not imagine.

The Trajectory

It is remarkable to consider that the inventions of the same man have played important roles in such diverse settings as the machine shops and factories of Akron, Ohio, and Detroit, Michigan in the 1940s and '50s, and the cleanrooms of California's Silicon Valley, today. In order to move from the one to the other, however, Ovshinsky had to change the way he worked. While his outsider origins and work as an independent inventor were crucial to making his discoveries, to take them further he needed to collaborate with scientific insiders, trained researchers who could develop, apply, and communicate his ideas. Using revenues from the growing commercial success of his switching inventions, he formed his own research and development company, Energy Conversion Devices (ECD), which by the 1980s had created and manufactured alternative energy technologies like nickel–metal hydride batteries and thin-film solar panels, for which Ovshinsky invented a system of continuous mass production to make solar power affordable. These energy technologies all depended on his pioneering use of amorphous and disordered materials, as do the information devices that may prove to be his most important contribution to 21st-century technology.

Stan Ovshinsky hosting Harley Shaiken and Ricardo Lagos at one of his continuous thin-film solar production machines in Detroit in 2009.

Photo by Brendan Ross.

Photo courtesy of The Ovshinsky Family and the Bentley Library.

Stan and Iris Ovshinsky.

Although Ovshinsky discovered phase-change memory in the early 1960s, its potential has only recently been realized. Its earliest application was an optical version that yielded rewritable CDs and DVDs, widely popular in the 1980s and '90s and still in use today. The more important electronic version, which has only recently entered production, has been claimed by Intel and Micron as "a major breakthrough in memory process technology" that promises new advances in computing. Ovshinsky's career thus spanned the transition from the Industrial Age of the mid-20th century to the Information Age we now inhabit.

But Ovshinsky did not simply join the ascendant information economy or accept the idea that we are living in a "post-industrial" era. He remained connected to his industrial roots and advocated the use of amorphous and disordered materials as the basis for new industries and the manufacturing jobs they could provide. As an emblem of his hopes for that future, he had a poster made in the early 1980s to commemorate the first roll-to-roll machine for mass-producing thin-film photovoltaic material. The poster juxtaposed images of the machine's long production line with those of Henry Ford's Model T and its assembly line. Just as Ford had transformed the economy of the 20th century, so Ovshinsky envisioned the transformative effects of the new industries he was working to create.

The Values

That poster also indicates the way Ovshinsky's work as an inventor was guided by his values. When he and his second wife, Iris Dibner, founded ECD in 1960, they dedicated the company to using science and technology to address social problems. With keen foresight, they chose to focus on energy, especially the industrial world's dependence on oil, which Ovshinsky already recognized as a cause of both pollution and war. His work thus offered not only a parallel to Ford's, but also a corrective to the problems caused by automobiles and other fossil fuel technologies. ECD's solar panels and batteries were its most successful alternative energy technologies, but Ovshinsky also developed others, like a hydrogen-powered car, part of his vision of an economy in which all fossil fuels would be replaced. Near the end of his life, battered by the loss of both Iris and his control of ECD, Ovshinsky continued his quest. With the encouragement of his third wife, Rosa Young, he started a new company to develop his ideas for a way to greatly increase the rate of solar panel production

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Photo by Scott C. Soderberg/Michigan Photography.

Stan Ovshinsky receives an honorary Doctor of Science degree from the University of Michigan, Ann Arbor, in 2010. At left, Michigan Governor Jennifer Granholm and President Barack Obama applaud. President Obama also received an honorary degree.

in order to make solar power cheaper than coal, a goal he pursued until his death in 2012.

Like his efforts as an inventor, Ovshinsky's social values were rooted in the experiences of his youth. Although he came to the realms of science and advanced technology as an outsider, he grew up inside a strong, cohesive working-class community. He was formed in the culture of politically conscious Eastern European Jews like his father Ben, who had come to America to escape arrest for his activism in Czarist Russia and who helped found the Akron branch of the Workmen's Circle, a fraternal organization dedicated to promoting social justice and creating "a better and more beautiful world." As a boy, Ovshinsky attended and spoke at meetings of the Workmen's Circle, which often welcomed speakers from New York and elsewhere, many of whom had left Europe to escape the Nazis or the Communists. The meetings were typical expressions of the secular, radical culture of Eastern Europe, to which Ovshinsky later looked back with fondness and regret. "We had a very rich life that won't be duplicated again. It was tremendously cooperative. They stuck together, helped each other. They were all bright and intelligent, even though they were carpenters, toolmakers, painters, rubber workers, shopkeepers, shoemakers, tailors."

In addition to participating in the Workmen's Circle, Ovshinsky was a leader in the Young Socialists' League while he was still in school. Later, he was a leader in union organizing and other forms of activism in struggles for economic and racial justice. Iris shared his values, influenced by the idealistic philosophical anarchism of her parents, and when she and her husband created ECD, they rooted the goals and culture of their company in their common beliefs. Ovshinsky considered himself a democratic socialist, but for him the point of socialism was practical: "to make a better life for working people, with education and so on."

Besides its ambitious environmental goals, ECD was dedicated to making life better for all its staff. For Stan and Iris, the ECD community was a social invention as important as any of its technologies. Its staff received generous pay and benefits; they were rewarded for their contributions and given opportunities and support to develop their abilities. Racially and ethnically diverse, ECD also included women at every level (with more women than men serving as vice presidents and equal numbers on the board of directors). "This," Ovshinsky explained, "was how we believed society ought to be."

The Legacy

Six years after Ovshinsky's death, we want to briefly reflect on his enduring contributions. The continuing influence of his discoveries and inventions is all around us in the devices we encounter daily, from flat-screen televisions to solar power, from electric and hybrid cars to the memory chips in smart phones. Current versions of these technologies may have moved on from their earlier ones, but they all depend in various ways on the use of amorphous and disordered materials, whose possibilities Ovshinsky first demonstrated.

Some of his inventions may be superseded, while others may become more important, but the larger significance of Ovshinsky's life arises from the way both his technological innovations and his leadership reflected his humanistic values and unquenchable optimism. Unlike many gifted innovators, Ovshinsky was not interested in building an empire or simply getting rich. For him, money was always a tool, a means to realize the Workmen's Circle's aim of creating a better and more beautiful world. His generosity, openness, and the passion with which he pursued his goals to the end of his life remain inspiring and, in our current regressive political moment, are needed more than ever. If there is to be the kind of better future Stanford Ovshinsky envisioned, both his inventions and his example will have helped to make it happen.

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Hoddeson and Garrett's new book *The Man Who Saw Tomorrow: The Life and Inventions of Stanford R. Ovshinsky* (MIT Press, 2018) is the first full-length biography of a visionary whose energy and information innovations continue to fuel our economy. Hoddeson and Garrett spoke for CLAS on September 20, 2018.

Stan and Rosa Ovshinsky at the Paranal Observatory in Chile's Atacama Desert, 2009.

Photo by Beatriz Manz.

Stanford R. Ovshinsky
(1922–2012)

He harnessed the sun,
he reached for the stars.

The night sky over the Paranal Observatory in Chile.
(Photo by Yuri Beletsky/ESO.)