

## Brain scan

# The Edison of our age?

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### **Stanford Ovshinsky may not be a household name, but his inventions have the power to change the world**

"THE ages of mankind have been classified by the materials they use—the Bronze Age, the Iron Age, the Age of Silicon. We are at the dawn of the Hydrogen Age." So proclaims Stanford Ovshinsky, co-founder of Energy Conversion Devices (ECD), a company based near Detroit, Michigan. "What is more," he says, "the hydrogen economy is happening already."

There have been plenty of grandiose but unsubstantiated claims made over the past five years about the potential for hydrogen to replace fossil fuels as an energy carrier, so some scepticism is certainly in order. In particular, President George Bush and the big carmakers have been trumpeting hydrogen fuel cells—electrochemical devices that turn hydrogen into electricity and water vapour—as the replacement for the internal-combustion engine. But the date of commercialisation seems forever slipping just beyond the horizon.

That has prompted a backlash from advocates of rival technologies (such as ethanol-based engines and novel batteries) and from greens, who argue that hydrogen is just a cynical long-term diversion used by Mr Bush and Detroit to avoid short-term action on fuel-economy standards, plug-in hybrids and other here-and-now options. And yet here is Mr Ovshinsky, still trumpeting hydrogen's virtues despite bitter opposition.

Three things set Mr Ovshinsky apart from the hydrogen hypesters. First of all, he is no newcomer. He first outlined his vision for what he calls a "hydrogen loop" some five decades ago as an alternative to fossil fuels. (The loop goes from water to stored hydrogen via solar-powered electrolysis, and from hydrogen back to water, generating electricity in the process, via a fuel cell.) Unlike others, he can hardly be accused of opportunistically seizing upon this obscure techno-fix for political reasons.

The second difference is that Mr Ovshinsky's green credentials are impeccable. He and his wife Iris, who died recently, founded ECD in 1960 with the explicitly stated goal of "using creative science to solve societal problems". Astonishingly, they had the foresight to predict—long before the oil shocks of



the 1970s—that the world's addiction to oil would have unacceptable side effects, from resource wars to climate change. Spend time with Mr Ovshinsky and his employees, and it becomes plain that his social values permeate his organisation.

But what lifts Mr Ovshinsky into the league of genius inventors is something rather less common: success. He is the inventor of the nickel-metal hydride (NiMH) battery, which is used to power everything from portable electronics to hybrid cars; around 1 billion such batteries are sold every year. He has also made advances in information technology (he calls information “encoded energy”) and holds critical patents relating to thin-film solar cells, rewriteable optical discs, a new form of non-volatile memory and flat-panel displays. These technologies are being commercialised through deals with Intel, Samsung, STMicroelectronics, General Electric, Chevron, United Solar Ovonic, and others.

## **Innovation from disorder**

What all these apparently disparate inventions have in common is that they rely on Mr Ovshinsky's path-breaking discoveries in the field of disordered or “amorphous” materials, since named “ovonics” in his honour. Such materials can be used for energy generation (in fuel cells and solar cells), for energy storage (in batteries), for computing (to store data on discs or in chips) and to create custom materials with novel properties.

Mr Ovshinsky has spent the past five decades devising actual working products, based on amorphous materials, that fill every niche in his hydrogen loop, from thin-film solar panels to solid-hydrogen storage tanks to “regenerative” fuel cells that can store energy captured while a car is braking. ECD has even “hacked” a Toyota Prius hybrid car so that it runs on pure hydrogen rather than petrol, which he says proves that “we don't have to wait for fuel cells to move into the hydrogen economy.”

All this makes it tempting to compare ECD's co-founder with Thomas Edison, the great inventor from another age who founded General Electric. Both established themselves early on not only as brilliant innovators, but inventors with their feet firmly planted on the ground. Both arose from humble roots: Edison was not born to privilege, while Mr Ovshinsky's father collected scrap by buggy. Mr Ovshinsky did not even go to college, and credits his vast knowledge of science to the public libraries of his native Ohio. He likes to say, “invention comes to the prepared mind.” And Edison, like Mr Ovshinsky, straddled the fields of energy and information technology: he originally made his name with the invention of the quadruplex, a device that increased the capacity of telegraph lines, before moving on to electrification.

Another similarity between the two inventors is that both thought of their inventions as entire systems. They had the verve to envisage a radically different world, but were good at inventing the practical things needed to get there. In Edison's case, his vision was that of mass electrification. He was not the first to make a light bulb, but he vastly improved it and, more importantly, created the generation and distribution technologies needed to make it work, from power stations to electricity meters. His company, now called GE, helped to light up America and then the world.

Despite his lack of formal training, the charming, soft-spoken Mr Ovshinsky is not at all threatened by scientists with fancy degrees: he hires many of them, and has hosted lively debates around a round table at ECD with such prominent scientists as Hellmut Fritzsche and Morrel Cohen of the University of Chicago, David Adler of MIT and Sir Neville Mott of Cambridge University (who went on to win a Nobel prize for work on amorphous materials). Ask him whether he expects his own Nobel, and he responds matter of factly: "Oh, never. I've been nominated before, and Mott gave me credit when he won his, but I'll never get one." Without a hint of bitterness he adds softly, "I'm not a part of their world."

Mr Ovshinsky's vision for a hydrogen loop was just a blackboard exercise five decades ago. But since then he has produced the inventions needed to make it work. "Stan starts with a vision, and then goes out to invent what we need to get from here to there," says Joachim Doehler, a senior scientist at ECD. Doing this requires more than scientific theory: it requires a practical engineer's mind too. "Stan is a very good toolmaker," says Robert Stempel, ECD's chairman (and a former boss of General Motors, a big carmaker). Mr Ovshinsky's collaborators say that he has an astonishing ability to juggle the permutations of eight or ten novel materials in his head, which gives him an intuitive grasp of which scientific leads to follow. That said, his colleagues joke, he still sometimes cannot remember names correctly.

The best evidence of Mr Ovshinsky's systems approach at work is his shiny new solar factory in Michigan. Several decades ago, he argued that solar panels ought to be made not as brittle crystalline panels in costly batch processes—how everyone else does it today—but in a continuous process, "by the mile". He was ridiculed. But he refused to yield, and asked his team to devise processes for producing miles of thin-film solar material. Dr Doehler, a veteran of AT&T's legendary Bell Labs research centre, recalls telling his boss it was impossible. The boss proved him wrong, personally designing much of the solar factory from scratch. Crucially, his approach does not require the expensive silicon used in conventional solar panels.

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**"Mr Ovshinsky may be 84, but he still dresses in natty suits and moves with a young man's energy."**

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## **A sunny future**

Mr Ovshinsky points to the happy result on the shop floor: a flexible, self-adhesive strip of solar material that makes power even on cloudy days and is virtually indestructible. The factory, which Mr Bush visited in February, has an order backlog of six months and profit margins approaching 30%, he says. He has another factory in the works nearby, and plans for more: "I see ECD's future as a factory for factories. That's how you build entirely new industries for the future." So does he see ECD as the GE of the 21st century? "Oh, ECD will be much more than that," says Mr Ovshinsky merrily. "Energy and information are the twin pillars of the global economy, after all."

How justified is this boast? Few question his intellect, but some do challenge his record as a corporate boss. An article in *Forbes* magazine asked in 2003 why investors "keep giving money to Stan Ovshinsky, the inventor who can create

anything but profits." ECD has lost money for most of the 40-plus years that it has been a public company. As even one of Mr Ovshinsky's loyal lieutenants confesses, "This company would have gone bust six times already if it were not for the personal loyalty people felt for Stan and Iris; we went the extra mile for them because this place is unique."

Inspired by the family's links to the peace and civil-rights movements, the Ovshinsky motto is "with the oppressed, against the oppressor", and ECD retains the feel of a family firm with those values. What is more, ECD is visibly committed to clean energy—and Mr Ovshinsky is clearly not motivated by money. The *New York Times* recently analysed executive pay in America and found that bosses typically get 500 times the salary of the average worker at their firms; the ratio at ECD is five to one. He even points out that he is "probably the only chief executive that is a union member".

The loss of his wife, collaborator and co-founder has clearly devastated Mr Ovshinsky, but do not expect to see him retire anytime soon. He may be 84, but he evidently has plenty of unfinished business to attend to. He still rises early, dresses in natty suits, and moves with the agility and energy of a young man. His intellectual curiosity appears entirely undiminished by a life of learning: his desk at ECD is buried under neat stacks of annotated scientific papers, business plans and other reading material. And he remains as audaciously inventive as ever.

He has worked out how his next generation of solar films will be produced not at 2.5 feet per minute, he says, but 100 times faster. He is convinced he can radically improve the efficiency of fuel-cell electrodes. He thinks he will be able to scale up his firm's hydrogen-storage system to megawatt scale, thus enabling grid storage of renewable power. And so on. As your correspondent departed at the end of a day-long visit, Mr Ovshinsky still had a dinner interview with a television crew, and then planned to work on a cosmology paper at home. As I.I. Rabi, a Nobel prize-winning physicist, is reported to have said when asked if his friend was another Edison: "He's an Ovshinsky, and he's brilliant."