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# The Story of the Invention That Could Revolutionize Batteries—and Maybe American Manufacturing As Well

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Image: This black goop is what will be at the heart of the next generation of batteries.(Kieran Kesner for Quartz)

*The world has been clamoring for a super-battery.*

Since about 2010, a critical mass of national leaders, policy professionals, scientists, entrepreneurs, thinkers and writers have all but demanded a transformation of the humble lithium-ion cell. Only batteries that can store a lot more energy for a lower price, they have said, will allow for affordable electric cars, cheaper and more widely available electricity, and a reduction in greenhouse gas emissions. In the process, a lot of gazillionaires will be created.

But they have been vexed. Not only has nobody created a super-battery; a large number of researchers have lost faith in their powers to do so—perhaps ever. Entrepreneurs such as Tesla's Elon Musk continue to tinker with off-the-shelf batteries for luxury electric cars and home power-storage systems, but industry hands seem generally to doubt that their cost will drop enough to attract a mass market any time soon. Increasingly, they are concluding that the primacy of fossil fuels will continue for decades to come, and probably into the next century.

This is where Yet-Ming Chiang enters the picture. A wiry, Taiwanese-American materials-science professor at the Massachusetts Institute of Technology (MIT), Chiang is best known for founding A123, a lithium-ion battery company that had the biggest IPO of 2009. The company ended up filing for bankruptcy in 2012 and selling itself in pieces at firesale prices to Japanese and Chinese rivals. Yet Chiang himself emerged untainted.

In 2010, having rounded up $12.5 million from Boston venture capital firms and federal funds, Chiang launched another company. Again, it was in batteries. And today, after five years in "stealth mode," he is going public. There may be a way to revolutionize batteries, he says, but right now it is not in the laboratory.

Instead, it's on the factory floor. Ingenious manufacturing, rather than an ingenious leap in battery chemistry, might usher in the new electric age.

When it starts commercial sales in about two years, Chiang says, his company will slash the cost of an entry-level battery plant 10-fold, as well as cut around 30% off the price of the batteries themselves. That's thanks to a new manufacturing process along with a powerful

new cell that adds energy while stripping away cost. Together, he says, they will allow lithium-ion batteries to begin to compete with fossil fuels.

But Chiang's concept is also about something more than just cheaper, greener power. It's a model for a new kind of innovation, one that focuses not on new scientific invention, but on new ways of manufacturing. For countries like the US that have lost industries to Asia, this opens the possibility of reinventing the *techniques* ofmanufacture. Those that take this path could own *that* intellectual property—and thus the next manufacturing future.

This is the story of how that came about.

24M batteries.(Kieran Kesner for Quartz.)

## Manufacturing, the new frontier of innovation

Traditionally, big innovations have happened at the lab bench. A discovery is made and patented, then is handed off to a commercial player who scales it up. With luck, it turns out a blockbuster product.

But, according to a report published in February by the Brookings Institution, researchers are increasingly skeptical of the delineation between innovation and production. Breakthrough-scale invention, they say, happens not only in the lab, but also in factories.

This is not a new idea. Until 1856, for instance, steel was an ultra-expensive niche product. It was far more robust than iron, but no one knew how to make it economically. Its use was confined to specialty hand tools and eating utensils for the rich. But then British inventor Henry Bessemer, stirred by French gripes about the fragility of cast-iron cannons, devised a process that reduced the cost of steel by more than 80%, roughly equivalent to iron. Steel—along with oil—went on to propel the latter part of the Industrial Revolution, along with the gargantuan 20th century economic boom.

If Bessemer had made his breakthrough today, it would be called "advanced manufacturing"—a label that has been broadly applied to next-generation fabrication methods such as 3D printing, modular construction of skyscrapers, and robotics. There is some hype around this term: The Brookings report identifies 50 industries in the US alone as "advanced," and historic factory hubs such as the English city of Sheffield are renaming themselves as variants of "advanced manufacturing cluster."

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Chiang and Wilder are about to embark on a third round of investment, seeking $20 million to $30 million. They would spend the money to scale up to production of a new machine that makes a cell every two to ten seconds. This machine, to be available for sale in two years, would be for stationary electric batteries—used to power businesses, neighborhoods and utilities, rather than cars.

The machine would have a capacity of 79 megawatt-hours a year and produce any kind of lithium-ion battery for a cost of about $160 per kilowatt-hour. By 2020, Chiang says, that will be down to about $85, 30% below where conventional lithium-ion batteries—whose cost is also dropping—may be by then. But most importantly, the machine would be priced at about $11 million. Hence, the startup cost of getting into lithium-ion battery manufacturing would plummet. “It’s so far out of the paradigm, you just don’t believe it,” said Wilder.

If 24M creates this machine, and if it can sell it into the market—an entirely different question—it will clearly shake up big industries, including stationary and electric car batteries, not to mention utilities. How quickly is anyone’s guess.

Chiang seems ambivalent as 24M begins to disclose what it’s been doing all these years. Until now, the entire industry has had a singular idea of how batteries are manufactured. Chiang’s own rivals were, until today, convinced that he was on a far-fetched crusade to figure out flow batteries.

But now, if they look hard at what he is really doing, and accept his approach, they may attempt to copy him. “If you haven’t seen the movie play out before, you don’t have the confidence it can be done,” he said. But staying a step ahead is also part of the startup game.

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