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Does America Need Manufacturing?

By JON GERTNER

You can drive almost anywhere in the state of Michigan — pick a point at random and start moving — and you will soon come upon the wreckage of American industry. If you happen to be driving on the outer edge of Midland, you'll also come upon a cavern of steel beams and ductwork, 400,000 square feet in all. When this plant, which is being constructed by Dow Kokam, a new venture partly owned by Dow Chemical, is up and running early next year, it will produce hundreds of thousands of advanced lithium-ion battery cells for hybrid and electric cars. Just as important, it will provide about 350 jobs in a state with one of the nation's highest unemployment rates.

Over the last two years, the federal government has doled out nearly $2.5 billion in stimulus dollars to roughly 30 companies involved in advanced battery technology. Many of these might seem less like viable businesses than scenery for political photo ops — places President Obama can repeatedly visit (as he did early this month) to demonstrate his efforts at job creation. But in fact, the battery start-ups are more legitimate, and also more controversial, than that. They represent "the far edge," as one White House official put it, of where the president or Congress might go to create jobs.

For decades, the federal government has generally resisted throwing its weight —and its money — behind particular industries. If the market was killing manufacturing jobs, it was pointless to fight it. The government wasn't in the business of picking winners. Many economic theorists have long held that countries inevitably pursue their natural or unique advantages. Some advantages might arise from fertile farmland or gifts of vast mineral resources; others might be rooted in the high education rates of their citizenry. As the former White House economic adviser Lawrence Summers put it, America's role is to feed a global economy that's increasingly based on knowledge and services rather than on making stuff. So even as governments in China and Japan offered aid to industries they deemed important, factories in the United States closed or moved abroad. The conviction in Washington was that manufacturing deserved no special dispensation. Even now, as unemployment ravages the country, so-called industrial policy remains politically toxic. Legislators will not debate it; most will not even speak its name.

By almost any account, the White House has fallen woefully short on job creation during the past two and a half years. But galvanized by the potential double payoff of skilled, blue-collar jobs and a dynamic clean-energy industry — the administration has tried to buck the tide with lithium-ion batteries. It had to start almost from scratch. In 2009, the U.S. made less than 2 percent of the world's lithium-ion batteries. By 2015, the Department of Energy projects that, thanks mostly to the government's recent largess, the United States will have the capacity to produce 40 percent of them. Whichever country figures out how to lead in the production of lithium-ion batteries will be well positioned to capture "a large piece of the world's future economic prosperity," says Arun Majumdar, the head of the Department of Energy's Advanced Research Projects Agency-Energy (ARPA-E). The batteries, he stressed, are essential to the future of the global-transportation business and to a variety of clean-energy industries.

We may marvel at the hardware and software of mobile phones and laptops, but batteries don't get the credit they deserve. Without a lithium-ion battery, your iPad would be a kludge. The new Chevrolet Volt and Nissan Leaf rely on big racks of lithium-ion battery cells to hold their electric charges, and a number of new models — including those from Ford and Toyota, which use similar battery technology — are on their way to showrooms within the next 18 months.

This flurry of activity comes against a dismal backdrop. In the last decade, the United States lost some five million manufacturing jobs, a contraction of about one-third. Added to the equally brutal decades that preceded it, this decline left large swaths of the country, the Great Lakes region in particular, without a clear economic future. As I drove through the hollowed-out cities and towns of Michigan earlier this year, it was hard to tell how some of these places could survive. Inside the handful of battery companies that I visited, though, the mood was starkly different. Many companies are working on battery-pack designs for dozens of car models. At the Johnson Controls factory in Holland, Mich., Ray Shemanski, who is in charge of the company's lithium-ion operation, said, "We have orders that would fill this plant right now." Every company I visited not only had plans to get their primary factories running full speed by 2012 or 2013 but also to build or expand others. Jennifer Granholm, Michigan's former governor, has predicted that advanced batteries will create 62,000 jobs over the next decade.

It is tempting to see in this the stirrings of an industrial revolution. These days, confidence is itself a rare and precious fuel, and in Michigan's nascent battery belt, there is no shortage of it. As the country's jobless rate hovers above 9 percent, could this manufacturing revival be part of the answer to the jobs crisis? Or is it merely an expensive government bet on a lost cause?

About 30 minutes northwest of Detroit, just off the Interstate, in Livonia, sits the modern, red brick automotive headquarters of A123 Systems, a beneficiary of about $375 million in federal stimulus funds and matching state grants. A123 provides the cells for a new electric car called the Fisker Karma, as well as various electric bus and truck projects around the world. A123 is also the first large-scale lithium-ion manufacturer whose domestic operations are up and running, though its pedigree is international. Its battery technology was developed at M.I.T., and for the last several years, the company had been making its lithium-ion cells in factories in Korea and China. When I asked Jason Forcier, the head of A123's automotive division, why the company went to Asia to make its products, Forcier said he had no choice. "That's where the supply base was," he said. "That's where the know-how was — it was nonexistent in the U.S."

Repatriating a high-tech manufacturing plant to the United States is not simply a matter of hiring the local talent. It requires good-old foreign know-how. "We call it 'copy exact,' " Forcier said. "We bought a company in Korea that had the technology around this type of battery and had developed the manufacturing process there. We basically brought that here, copied it exactly and scaled it up." A123 also brought a team of six Korean engineers to help transfer the technology to the U.S. and sent a team of Americans to Korea to learn.

I heard a similar story at LG Chem Power — a battery start-up and an American subsidiary of LG Chem, a Korean firm. LG Chem is building a factory in Holland, Mich., to make batteries for the Chevy Volt. Production depends on replicating the company's lithium-ion plants abroad, down to the smallest detail. "In fact, we're making it like a copy — cut and pasted from Korea to here," Prabhakar Patil, the C.E.O. of LG Chem Power, said.

Neither Forcier nor Patil made any apologies. Each told me that the moves to Michigan provided them with a skilled work force and operating expenses that are largely competitive with factories abroad. (Only 5 to 10 percent of the cost of a battery cell, Patil told me, comes from labor; material accounts for the bulk of expenses.) Each also saw his company's strategy of importing manufacturing technology to the United States as imperative. A state-of-the-art lithium-ion battery plant is as different from an automobile plant as a science lab is from a gymnasium. Cell-making — the automated administration of thin chemical coatings on the batteries' inner components; the mechanized cutting and folding of metal parts; the workers in sanitary "bunny suits" overseeing conveyor belts that move pristine cells through sealed assembly chambers — is painstakingly precise. A stray hair or a drop of sweat can ruin a lithium-ion cell. "Don't touch anything," Forcier advised me as we began to walk through the factory at A123.

Lithium-ion cells like the ones made at A123 probably don't look like any battery you've ever used. They are stiff, rectangular, metallic-colored envelopes, roughly the dimensions of a thin trade paperback, with two small tabs. Individually, the cells aren't much use for a car; they must be stacked with others in modules or packs. The Chevy Volt, for instance, has a pack of 288 cells, wired together and running down the center of the car. The pack is the most expensive and sophisticated element of the car, much in the way the processor is the most important element of a computer. Everything about the cell pack — its interior chemistry, its unifying electronics, its cooling systems — is variable and made to order. "With G.M., we've been working for two years on their exact requirements for the next-generation Volt," Michael Sinkula, a founder of a battery-component company called Envia Systems, explained. "They say: 'We want it to perform this way. Is that possible?' And then we tell them if it's possible."

The Volt is just one car, of course — one whose sales are unremarkable. Still, the global automobile market is so large that even modest gains in market share could spark tremendous growth for battery-makers. "If you look at the year 2016, and you say, 'Only 5 percent of the market is electrified?' Well, that's a $14 billion market for lithium-ion batteries," Forcier says. "To hit 5 percent is a huge number of vehicles. And the business around making lithium-ion batteries for 5 percent of the world's cars is a huge, huge business."

In the late '80s, Patil, of LG Chem Power, was working at Ford, trying to build a pure electric-battery vehicle called the ETX and getting nowhere. He was using a more primitivelead-acid battery technology. Automotive engineers tend to use two distinct measures — power and energy — to evaluate battery chemistries. Power relates to acceleration; energy relates to how far a car can travel before it needs to be recharged. The ETX wasn't good by either yardstick. "The car went 0 to 60 in 12 seconds," Patil recalls. "Its range was 60 miles on a good day." The lead-acid batteries were so heavy that the cars were nicknamed lead sleds. With a performance and range so inferior to a typical gasoline vehicle, how could you expect a consumer to pay a premium — what was then about $10,000 — for it?

Eventually, lead-acid batteries yielded to nickel-metal hydride, which was incorporated into the Toyota Prius and, later, a range of hybrid vehicles. At the same time, a more promising battery chemistry based on lithium — with far greater potential for both power and energy — was being developed by various scientists, notably John Goodenough at the University of Texas. Sony was the first company to broadly adapt the lithium technology at its factories in the early 1990s; the company consistently improved the product and began incorporating it into consumer-electronic devices. But automakers couldn't figure out how to cost-effectively adapt the technology. Patil recalls a "chicken-and-egg problem" as he tried to build a Ford Escape hybrid in the late 1990s. "I used to get thrown out of C.E.O.'s' battery offices regularly," he said. "They said: 'Show me the market. Otherwise, leave.' " Patil knew there could be no market in the United States without significant drops in the batteries' price and significant increases in their performance. But it was a Catch-22. Improvements in price and performance

were impossible unless companies became serious about manufacturing.

Federal agencies like the Department of Energy have long financed scientific research — through university grants, for instance — on technologies like lithium-ion batteries. But a basic feature of government policy is to allow corporations and entrepreneurs to pick through the results of that research, commercialize the promising ideas and let the market sort things out. In other countries, it often works differently. Governments are more willing to help companies pool information about a new industry or technology and (especially in Korea and China) assist with the early-stagecommercialization of products, including the construction of plants. While Patil was getting booted from executive offices at Ford, companies in Asia, in some cases with a boost from their governments, focused on streamlining the manufacturing process. Battery performance steadily improved, and costs dropped. By the mid-2000s, it was clear that if the lithium-ion battery continued to get better at the same rate, the product might soon be suited for automobiles.

In January 2009, two weeks before Barack Obama's inauguration, Senator Carl Levin of Michigan sent a letter to Obama and his advisers — Rahm Emanuel, David Axelrod and Lawrence Summers — about the promise of lithium-ion technology. "The country or region that controls and dominates the production of batteries will also ultimately control green-vehicle production," Levin said in a speech he later gave to the Senate. Levin's efforts effectively laid the groundwork for battery grants to be part of the $787 billion American Recovery and Reinvestment Act.

"It was a calculated risk — a lot of money, to be sure, but given the stakes, I think it was a pretty thoughtful bet," says Ron Bloom, who recently served as an assistant to President Obama for manufacturing policy. "If vehicle electrification really does take off, as many, many people think it will, and we're not part of it, then we could lose our leadership of the global automobile industry." Which would be catastrophic. By some estimates, as much as 20 percent of all manufacturing jobs are directly or indirectly related to the automobile industry. Bloom points out that the United States is not the only country betting on batteries; a number of Asian countries have done so as well.

On both sides of the world, the fundamental appeal of expanding manufacturing is jobs. It is a curiosity of modern life that information companies can create extraordinary social disruptions and vast shareholder wealth but relatively few jobs. Facebook has about 2,000 employees worldwide. Google has about 29,000. Even in its new, slimmed-down state, General Motors, a decidedly less valuable company, has about 200,000 employees. What's more, that number represents only a fraction of the people behind the production of a G.M. car. "When you're manufacturing anything, even if the work is done by robots and machines, there's an incredible value chain involved," Susan Hockfield, the president of M.I.T., says. "Manufacturing is simply this huge engine of job creation." For batteries, that value chain would include scientists researching improved materials to companies mining ores for metals; contractors building machines for factory work; and designers, engineers and machine operators doing the actual plant work. By some estimates, manufacturing employs about 65 percent of America's scientists and engineers.

Hockfield recently assembled a commission at M.I.T. to investigate the state of American manufacturing and to offer a plan for its future. "It has been estimated that we need to create 17 to 20 million jobs in the coming decade to recover from the current downturn and meet upcoming job needs," she said at a conference this past March. "It's very hard to imagine where those jobs are going to come from unless we seriously get busy reinventing manufacturing." This logic has been endorsed by Jeffrey Immelt, General Electric's C.E.O.; Andy Grove, the former chairman of Intel; and Andrew Liveris, Dow Chemical's C.E.O. A widely circulated 2009 Harvard Business Review article — "Restoring American Competitiveness," by two Harvard professors, Gary Pisano and Willy Shih — has become one of the touchstones of the manufacturing debate. In the article, Pisano and Shih maintain that U.S. corporations, by offshoring so much manufacturing work over the past few decades, have eroded our ability to raise living standards and curtailed the development of new high-technology industries.

When I spoke with Pisano, he noted that industries like semiconductor chips — the heart of computers and consumer electronics — require the establishment of "an industrial commons," the skills shared by a large, interlocking group of workers at universities and corporations and in government. The commons loses its vitality if crucial parts of it, like factories or materials suppliers, move abroad, as they mostly have in the case of semiconductors. At first the factories leave; the researchers and development engineers soon follow.

The most punishing effect, however, may be the one that can't be measured — the technologies and jobs that aren't created because the industrial ecosystem is degraded. The semiconductor industry, for example, led to the LED-lighting and solar-panel industries, both of which are mostly based in Asia now. "The battery is another fascinating example," Pisano told me. "The center of gravity is Asia. But why?" If you go back to the 1960s, he says, the American consumer-electronics companies decided they were better off in Japan, and then Korea, where costs were lower. "And then you have to ask: Who had the incentives to make batteries smaller or more powerful or last longer? Not the car industry. The consumer-electronics industry did." This explains why the U.S. is now playing catch-up with lithium-ion batteries. It also underscores the vulnerability of an economy with a shrinking manufacturing sector. "When one industry moves," Pisano says, "there can be other industries in the future that follow it that you couldn't even anticipate."

Even in the battery industry, there are skeptics. Menahem Anderman, a California-based consultant, says that transforming

10 percent of the world's automobiles into either plug-in hybrids or electric vehicles by 2020 is a pipe dream. His projection is for less than 2 percent. U.S.-based factories, he says, are at a disadvantage. The U.S. industry, he told me, "was not ready to take in $2 billion from the government and spend it wisely. And so now we will build a lot of plants, and we will create overcapacity, and a lot of the companies will fail." He has no ideological objection to federal support, he adds, "but the status of the technology and the market were incompatible with the desire of the government to create manufacturing jobs." For pure electric vehicles in particular, which will likely need an expensive battery replacement within 10 years, Anderman still sees the dilemma Patil faced at Ford in the '90s, when he questioned whether consumers would pay $10,000 more for an inferior car. As Anderman puts it: "Has there ever been, in the modern history of capitalist countries, a new product for which the mainstream customer paid more for less?"

By his math, gas prices have to reach about $7 a gallon to make plug-in electric-hybrid vehicles attractive to consumers. To create demand for fully electric vehicles, gas prices would have to rise even higher. Which means generous government subsidies for purchases of these vehicles. Currently, Chevy Volt owners receive a tax break that brings the cost of the car down to about $33,500, from $41,000. In Washington, several people told me that unless there is consistent and increasing demand, taxpayers will have helped build an industry to nowhere. This fear is what turned so many politicians and policy makers against industrial policy in the first place. When government-backed ventures fail, taxpayers are left on the hook.

For now, battery makers think they can bring down costs quickly enough to be competitive. Improvements in the manufacturing process — spreading a better chemical coating on the sensitive elements inside the batteries, for instance, or raising the plant's conveyor belt speed ever so slightly — will increase quality and efficiency. I also heard talk of start-ups in California working on new cost-effective chemistries. "We see prices over the next five years coming down 50 percent," A123's Forcier told me. "And it's easy to say that, because we're quoting 2014 business, and we know what the prices are."

Whether this adds up to American jobs is less clear. The hope is that lithium-ion plants will seed a network of new chemical and equipment providers. To some extent, this has already happened. Some Japanese and Korean companies have set up shop in the United States, and local colleges are offering training courses for aspiring lithium-ion-battery factory workers. But it's a fragile ecology. Job numbers are small relative to the huge plants of Detroit's past. As the former labor secretary Robert Reich pointed out, high-tech manufacturing is increasingly automated. At capacity, the lithium-ion factories in Michigan will each employ between 300 and 400 people. Even the most optimistic forecasts — enough hybrid- and electric-car demand to necessitate several dozen factories — suggest the battery industry can't significantly offset declines in American manufacturing.

Which doesn't mean that it's a bad investment. If nothing else, the Obama administration's efforts in Michigan reawaken the conversation about industrial policy. To a large extent, this is an old war among Washington politicians. In the 1970s, it was fought over the federal bailouts of Lockheed and Chrysler — and a few years later during debates over whether the country needed to assist domestic companies in their efforts to gain ground on the Japanese in the semiconductor industry. By the time George H. W. Bush ascended to the presidency, the move away from industrial policy was clear.

"All you had to do in the 1980s was say, 'That's industrial policy,' and it killed anything it was hurled at," says Senator Levin, who along with Senator Sherrod Brown of Ohio is now among the most vocal advocates of such a policy**.** "It was the kiss of death. And it set us back 10 to 20 years in terms of manufacturing in America." What is different now, Levin argues, is that "our companies are not competing with those companies in Korea and Japan. They're competing with those governments that are supporting them. It's naïve to believe that we just have to let the markets work and we'll have a strong manufacturing base in America." In his view, the lithium-ion investments are tantamount to repairing a kind of market failure.

The battery executives I spoke to viewed the stimulus money as a once-in-a-lifetime opportunity. None seemed to think a federal windfall would come their way again. None saw their business endeavors as inherently political or ideological. And none seemed to believe they could survive if they didn't drive battery costs down and demonstrate that they could compete with the best lithium-ion factories abroad. "My own feeling is this will happen just as the government incentives wear off," Patil told me. "By then it has to become a self-sustaining business, and we actually see a line of sight to get there."

If the battery stimulus ultimately succeeds, does it demonstrate that expanding the United States' economy only through knowledge and services is no longer a viable strategy? "All of the great new American companies of the past few decades," says Suzanne Berger, a chairwoman of M.I.T.'s panel on the future of American manufacturing, "have focused on research and development and product definition — Apple, Qualcomm, Cisco." These were technology companies that could take full advantage of what she calls the "modularity" of the global economy. Their genius resided in the design of their gadgets and information systems; offshoring the industrial work did not leave them at a disadvantage. It did the opposite, greatly reducing costs and raising profits. "Now I think we're at a really different moment," Berger says. "We're seeing a wave of new technologies, in energy, biotechnology, batteries, where there has to be a closer integration between research, development, design, product definition and production."

One challenge to moving in this direction may be that our banks, hedge funds and venture capitalists are geared toward investing in financial instruments and software companies. In such endeavors, even modest investments can yield

extraordinarily quick and large returns. Financing brick-and-mortar factories, by contrast, is expensive and painstaking and offers far less potential for speedy returns. Berger maintains that for the economy to get “full value” from our laboratories’ ideas in energy or biotech — not just new company headquarters but industrial jobs too — we must aspire to a different business model than the one we have come to admire.

Which is to say, companies that have a passing resemblance to A123 Systems in Livonia, Mich. Or to use a more familiar example, a business that looks less like Google and more like Ford.

Jon Gertner (jongertner@gmail.com) is an editor at Fast Company. His book "The Idea Factory: Bell Labs and the Great Age of American Innovation" is due out in March.

Editor: Dean Robinson (d.robinson-MagGroup@nytimes.com)