Chapter 1

The Rise and Fall

In 2007, in a secretive Silicon Valley research facility known only as Lab 126, engineers and designers successfully developed a new product with the potential to revolutionize the way we read books like this one. It was called the Kindle, and it would represent Amazon's first attempt at selling a product of its own.

What was special about the device was not just that it was a portable library of books, but that it used an innovative electronic ink. Unlike the pixels of a standard computer screen, the tiny capsules of electronic ink change what appears on the screen without

illuminating it, allowing the Kindle to simulate a printed page and to be read even in direct sunlight.

The team at Amazon was excited about the potential of their product and began to search for a U.S. company that could manufacture it. To produce the special ink beads, Amazon partnered with a Massachusetts-based company, appropriately named E-Ink. The company had been started by researchers working at the MIT Media Lab and was now one of the only manufacturers in the country capable of producing electronic ink devices.

But E-Ink did not have the technology to build the Kindle screen itself. For Amazon to build the entire product, the company would have to partner with an additional manufacturer.

That search began in the United States; but it did not end there. The production technology required to build the screen was similar to what's used to make LCD televisions. Amazon needed a manufacturer with experience in that field. But there was a problem: Amazon couldn't find one in the United States. Though the LCD television was originally the product of American research and development (R&D), the entire industry had been ceded to Asia in the 1990s, when Asian countries offered U.S. television manufacturers a business environment too attractive to resist. By 1995, not a single LCD panel was being manufactured in the United States.*

As a result, Amazon was forced to look overseas to find a manufacturer with the expertise and capability to make the Kindle screen. Eventually, Amazon turned to a Taiwan-based company. The irony was a painful one for U.S.-based Amazon. Though its innovative new product had been developed in America, it would

*Olevia started manufacturing LCD television in the United States in 2006. But according to *Popular Mechanics*, the panels themselves are manufactured in Asia, and are only assembled in the United States.

not—could not—be built in America. Today, as Harvard Business School professor Willy Shih has said, when a Kindle is purchased by an American consumer, it adds to our trade deficit.

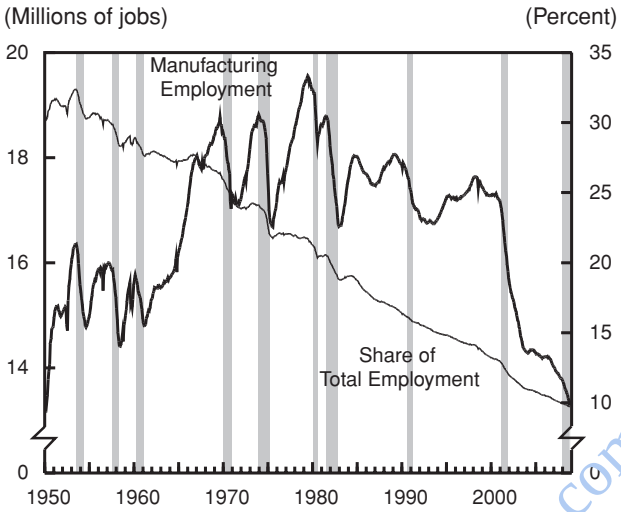
Not long after Kindle production began, the Taiwanese manufacturer, Prime View, realized that it could make the Kindle at a lower cost if an ocean wasn't separating the building of the screens from the creation of the ink. As a result, Prime View bought E-Ink and moved its headquarters—and the electronic ink industry—to Taiwan.

The story of the Kindle is not unique. On the contrary, it is becoming a defining experience of the U.S. manufacturing sector.

Over the past several decades, the United States has watched entire industries disappear from its shores—only to reappear abroad. Industries from solar panel technology to highly advanced computer circuitry, from wind turbines to smart phones—industries that were born in the United States—now exist predominantly elsewhere. Between 2001 and 2010, U.S. companies were forced to shutter more than 42,000 factories. A third of all manufacturing jobs—a full 5.5 million—have disappeared. The entire sector is hemorrhaging.

Today, instead of manufacturing making up 28 percent of GDP, as it did in the 1950s, it makes up just 11.5 percent. Instead of exporting billions more than we import, the United States now faces a half-trillion dollar trade deficit.

As Richard McCormack, a leading thinker on manufacturing issues, has noted in *The American Prospect*, the furniture industry lost at least 60 percent of its production capacity in the United States between 2000 and 2008. By 2009, the U.S. auto industry was in shambles, requiring a federal bailout to survive. The Chinese are now the global leader in auto manufacturing; in 2008, they made half a million more cars than the United States. General



Manufacturing Employment Since 1950

SOURCE: Congressional Budget Office: Factors Underlying the Decline in Manufacturing Employment Since 2000.
DATA SOURCE: Based on data from Department of Labor, Bureau of Labor Statistics.

Motors, once America's largest manufacturer, now plans to build cars in China and export them back to the United States. Wages in textiles, textile products, and apparel are expected to be cut in half by 2018.

Perhaps the most telling statistic of all: In 2008, 1.2 billion cell phones were sold worldwide. Not a single one was built in the United States.

How We Fell Out of Love with Manufacturing

How did a nation that once defined and distinguished itself by the things it built, a nation whose economic engines were driven

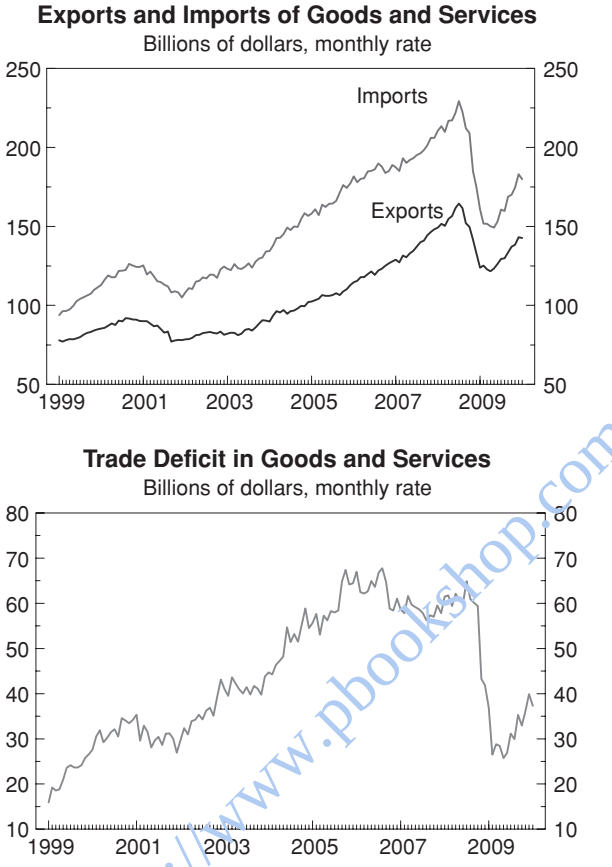
by manufacturing, end up ceding its identity—and its future—to other nations?

The United States used to be the world's greatest manufacturer. After World War I, U.S. manufacturing ability made the country an economic leader among nations. After the Great Depression, it was manufacturing—specifically, the manufacturing of war materiel—that led the United States out of the depths of economic despair. In 1953, General Motors alone generated 3 percent of U.S. gross national product. For the 30 years after World War II, America experienced a post-war boom driven by manufacturing that helped build a vibrant middle class, not just in the United States, but around the world. Between 1947 and 1973, family incomes doubled. According to the State Department, gross national product grew 50 percent between 1940 and 1950 and another 67 percent between 1950 and 1960.

From the time of America's founding, manufacturing growth defined the nation's economic strength. That changed in the mid-1970s. In 1975, we were still exporting more goods than we were importing. But that was the last time we did so. In the 35 years since, the United States has consistently been burdened with a trade deficit.

Other major world powers had fully rebuilt their manufacturing bases after World War II, thanks largely to the Marshall Plan. That led to increased competition abroad. The United States signed onto multiple free trade agreements, reducing the barriers to importation. Cheap products from China and India, from Taiwan and Brazil, began flooding the U.S. marketplace.

Through the 1980s and 1990s, the United States continued to manufacture more goods than any other country. But competition from developed and developing countries alike was putting a strain on manufacturers across the board. By the 1990s, the fall



*Note: Services totals include revisions to the December 2009 data.

Trade Deficit

SOURCE: International Trade Administration: U.S. Export Fact Sheet, January 2010.

of Communism ushered in a new era of free markets. Even China, which many believed might keep its economy closed, turned its engines full-tilt toward capitalism of a distinctly Chinese variety. In 2001, China joined the World Trade Organization. By opening

up its economy and breaking down major trade barriers, the Chinese could rival the United States as the highest-producing manufacturing nation in the world.

The rise of the Internet, too, marked a major turning point for global manufacturing. It allowed businesses to communicate and partner more easily with foreign suppliers. It made the world smaller, more interconnected. It lowered the barriers of entry into emerging markets and made it cheaper to operate a far-reaching global supply chain.

For many businesses, these opportunities brought levels of success previously unimaginable. As companies entered emerging global markets, they found not just those who could produce their goods, but those who could consume them.

This free flow of global capital gave businesses a greater choice of where to build a new factory or plant. It encouraged countries to aggressively compete for foreign investment, knowing that if they could attract new business, they could build their economies. In addition to offering cheap labor, countries offered businesses lower tax rates and easier-to-navigate regulatory regimes, among other incentives. When manufacturing companies assessed their financial position, it started to make more sense for them to move jobs offshore than to continue to operate in the United States.

And so they did. And today, as a result, the entire U.S. manufacturing sector is in crisis. The scaling process—the process of taking an idea out of the lab to mass production—is barely happening here anymore. Ideas born here are getting built elsewhere.

At the same time, America shifted its focus from manufacturing to the service sector. In some sense, this was to be expected. Our current generation of business and political leaders grew up, for the most part, in the post-war period. This was a time not only of economic stability, but of sustained prosperity. Many of

the children of that time period had parents who worked on the assembly line—and hoped for a life for their children outside the factory. Perhaps a white-collar job, a position in management. Or a professional degree and a career as a lawyer, a doctor, a banker. This was the great era of upward social mobility—always a proud feature of American life, and never more so than in the boom years of the 1950s and 1960s. Indeed, the prosperity of that period allowed millions of young Americans to get a better education than their parents, and, ultimately, to get a better paying, higher valued job.

This was all a uniquely American success story. But it had unforeseen consequences, some of which are only now becoming clear. These consequences were cultural and economic. What happened was that somewhere along the way, a leadership class emerged—in the public and private sector—that no longer valued the manufacturing sector. Yes, they were grateful for the sacrifices their parents had made on their behalf—but they had come to see manufacturing as merely a phase of economic development, something that a nation eventually outgrows, just as they had. So we populated the corporate world with service professionals, and filled Congress and the White House with lawyers and lobbyists, leaving manufacturers on the margins of our public dialogue.

As the manufacturing sector slowly sunk into a sustained crisis, there weren't enough people in positions of leadership who truly understood its importance, who truly appreciated the risks we faced if we let the sector erode.

What ultimately happened to the manufacturing base in the United States, then, was not the product of fate. It was the product of choices we made as a nation.

The Multiplier Effect

Most politicians and business leaders acknowledge that manufacturing is an important part of the economy. They travel the country, particularly traditional manufacturing areas, and talk in front of crowds at manufacturing outfits. Let us assume that these people are sincere when they proclaim their fidelity to manufacturing and manufacturing jobs. However, what they fail to recognize is that the loss of American manufacturing is going to be felt far beyond the streets of working-class Rust Belt communities. It is going to affect far more than the families who have lost jobs, and the towns that have lost entire companies. It's going to affect almost everyone. Because without manufacturing, the U.S. economy cannot—and will not—sufficiently grow.

Let me explain why:

Manufacturing, more than any other sector, creates jobs outside its own sector. These jobs range from construction and mining to jobs in fields like packaging and telecommunications. Even in 2009, a year when manufacturing was experiencing its sharpest decline to date, the sector still supported nearly 7 million nonmanufacturing jobs—jobs outside the plant. Those are jobs along an extensive supply chain.

We call this the multiplier effect. A new manufacturing facility will create demand for raw materials, construction, energy, supplies, and services. According to the U.S. Bureau of Economic Analysis, of all sectors, manufacturing has the biggest multiplier effect. As the Manufacturing Institute notes, "every dollar in final sales of manufactured products supports $1.40 in output from other sectors of the economy." Compare that to the service sector, which, according to the National Association of Manufacturers, supports just half as

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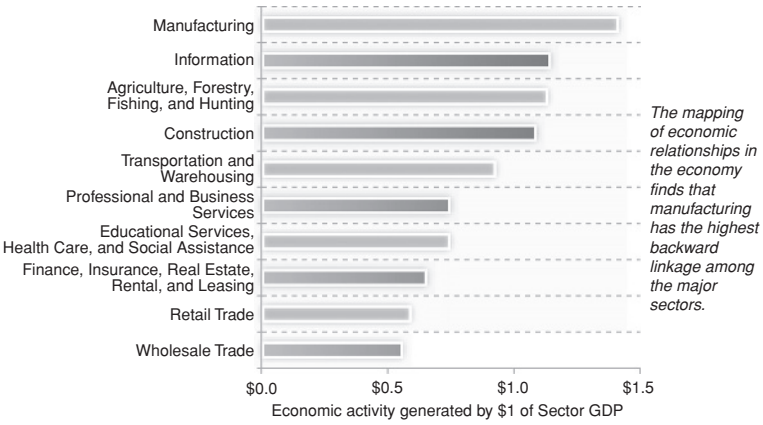

The mapping of economic relationships in the economy finds that manufacturing has the highest backward linkage among the major sectors.

The Multiplier Effect

SOURCE: Copyright © 2009 by The Manufacturing Institute. *The Facts about Modern Manufacturing, 8th ed.* 2009.
DATA SOURCE: U.S. Bureau of Economic Analysis, 2007 Annual Input-Output Tables.

much—$0.71—in output for every dollar in final sales. These are high paying jobs that we lose every time we move a plant offshore.

Consider the iPhone. Open the box of a brand new iPhone and you will read this proud statement: "Designed by Apple in California." Now look at the back of the device and you will find, in letters so small they are difficult to read, this admission: "Assembled in China." That's a story we know all too well.

But what if, instead, the back of the iPhone read, "Designed *and* Assembled in California"? What would be the difference for the U.S. economy? If Apple were to open their factory next to their R&D facilities in the Silicon Valley, instead of Shenzhen, it would create jobs in California for an entire supply chain.

Businesses from packaging and office equipment to telecommunication services and building maintenance would have reason to hire new workers. Companies that mine raw materials would

have reason to increase production. Local restaurants would have new customers. Local malls would have new patrons. The plant would become a new economic engine, leading to thousands of new jobs in town. The iPhone would create a mini-economy right here at home. A few hundred jobs inside the factory could mean a few thousand jobs outside of it.

Open that facility in China—or any other country—instead, and all those jobs, all that opportunity and prosperity, evaporate. New jobs and a new supply chain will emerge around the Chinese factory, and the wealth that could have been added to our economy will be added to theirs. Apple shareholders still see their returns. The engineers in California still get their paychecks. But the fruits of their labor accrue elsewhere. Indeed, for every Apple worker in America, there are 10 Apple workers in China.

But that isn't the only reason that manufacturing is a prerequisite for the level of economic growth we need. Manufacturing also adds value to the economy in a way and at a higher rate than other sectors. I'll explain this further in Chapter 2.

Manufacturing is also the primary driver of research and development, generating new ideas, inventions, and intellectual property that fuel long-term growth. More than two-thirds of the money spent on R&D in the United States is spent in manufacturing. Without a vibrant manufacturing sector, that R&D will be done not by the United States, but by its major competitors. Over time, that will leave America dependent on intellectual property that's created by other countries; America's ability to generate its own growth will atrophy. This, too, will be explained further in the next chapter.

The United States, therefore, cannot sustain the level of growth it needs—and has come to expect—without a stronger manufacturing sector. That presents a serious challenge. The United

States, like any nation, needs its economy to constantly grow. Every day the population increases. Every day new workers join the workforce—or seek to do so. According to the Economic Policy Institute, the United States has to create more than 125,000 new jobs every month just to keep pace with population growth. As we grow, the economy must grow with us.

Healthy economic growth results in higher wages, higher profits, a stronger middle class, and a better standard of living. It is the engine by which we prosper. Without economic growth, wages will stagnate, as will profits. The unemployment rate will stay high. Reductions in standard of living will be felt across the board. Without economic growth, the American dream, as we've imagined it, will come to an end.

Manufacturing Tomorrow

Designing here and building there is sometimes smart, sometimes necessary. But in general, it is simply not a formula for long-term economic success. If we want to create jobs in the United States—as we surely do—we cannot ignore manufacturing. We must revive it.

Yet, if this problem is so critical to the economy—and it is—it begs the question: Why haven't our political leaders focused on it? Sure, we hear lip service when presidential candidates are campaigning in Youngstown, Ohio, or Allentown, Pennsylvania, but why haven't concrete actions followed those words?

I believe part of that problem is a fundamental misunderstanding of what manufacturing is, and what a new manufacturing sector in America would be.

Too often in our political dialogue, when people talk about manufacturing, they talk about it in the wrong way:

"Are jobs that were a relic of an earlier time ever going to return? Are the jobs that have gone overseas worth bringing back?"

We heard this conversation a lot during the 2008 presidential election. While traveling through Michigan in January 2008, former Massachusetts Governor Mitt Romney told voters, "I hear people say, 'It's gone, those jobs are gone, transportation's gone, it's not coming back.' I'm going to fight for every single job. I'm going to rebuild the industry."

Senator John McCain, in response: "I've got to give you some straight talk. Some of those jobs that have left the state of Michigan are not coming back. They are not. And I am sorry to tell you that."

This debate misses the mark. Too often, the players in these debates are either arguing that we should revive the manufacturing jobs of the past, or instead, that we ought to write off the entire sector. But I'm not arguing that we should bring the jobs of the 1930s, 1940s, or 1950s back to our country. I'm not interested in restoring the manufacturing sector of old. I'm arguing that we should build a different kind of sector, an advanced manufacturing sector, one that offers high paying jobs in high-tech, state-of-the-art industries. Industries of the future. Industries that are changing the world. Industries that are changing the way we live in it.

When we create advanced microprocessors that can double the speed of the fastest computers, that's manufacturing. When we construct wind turbines that can power an entire city without any carbon emissions, that's manufacturing. When we create chemicals that can dramatically improve the life of a hybrid battery, that's manufacturing. When we build complex robotics that can assist a neurosurgeon in removing a brain tumor, that too is manufacturing.

It's not the industries of the past I'm worried about losing. It's the industries of the future.

And they're already disappearing.

For more than 30 years, for example, the U.S. government funded research and development labs that produced some of the most important breakthroughs in solar energy. According to the Department of Energy, the United States spent $15.4 billion (in 2008 dollars) between 1978 and 2007 on renewable energy R&D. But it was Japan—not the United States—that commercialized those panels. And now it's China—not the United States—that dominates the solar manufacturing industry globally. That massive national investment of $15.4 billion has created a U.S. solar manufacturing industry that today employs just 10,000 people.

As Intel founder Andy Grove wrote in *BusinessWeek*, "Today, manufacturing employment in the U.S. computer industry is about 166,000 lower than it was before the first PC, the MITS Altair 2800, was assembled in 1975. Meanwhile, a very effective computer manufacturing industry has emerged in Asia, employing about 1.5 million workers." He also notes that the biggest of these Chinese companies, Foxconn, saw its revenues in 2009 hit $62 billion, "larger than Apple, Microsoft, Dell, or Intel. Foxconn employs over 800,000 people, more than the combined worldwide head count of Apple, Dell, Microsoft, Hewlett-Packard, Intel, and Sony."

By ceding these industries to other countries, we aren't just losing out on today's manufacturing jobs. We're losing out on the production of tomorrow's innovations, on the progeny of the products being built today.

Some disagree. Princeton University economist Alan Blinder sees only upside to our loss of the television market, for example. "The TV manufacturing industry really started here, and at one point employed many workers," he wrote in his book, *Offshoring of American Jobs*. "But as TV sets became 'just a commodity,' their production moved offshore to locations with much lower wages.

And nowadays the number of televisions sets manufactured in the U.S. is zero. A failure? No, a success."

But it wasn't just televisions we lost. As Andy Grove notes, "Not only did we lose an untold number of jobs, we broke the chain of experience that is so important in technological evolution. As happened with batteries, abandoning today's 'commodity' manufacturing can lock you out of tomorrow's emerging industry."

This, as I described earlier, is exactly what happened with the Kindle. It may have been the previous generation of innovations—LCD televisions—that the United States gave up on producing. But it was the next innovation—the Kindle—that the United States, as a result, wasn't able to build.

It's that dynamic that could deliver a death blow to U.S. manufacturing. As other countries master next-generation manufacturing techniques, and as they gain expertise in innovation, the United States could find itself falling behind for good, and out of a game whose rules America used to write.

Surviving the Crisis

The companies that have survived have been those that were able to transform, to adapt their business models to match the changes in the global economy. At Dow, that is a story we know well. With new global markets and high volatility in basic resources, for Dow to continue to thrive, it had to change.

Through Dow's growth from a small business in Midland, Michigan, to a major multinational corporation, we focused primarily on producing basic chemicals. We were known as "the chemical company's chemical company." Most of the products we

sold were chemicals and plastics that would be used by other chemical manufacturers to produce even more advanced chemicals.

But in this new age, it made little sense—from a financial perspective—for us to continue our focus just on a basic chemicals portfolio. At Dow we recognized that we needed to transform ourselves, reorient our mission, our plan, and our projects toward products that yielded higher value and higher demand.

Today, that transformation is nearly complete. Two-thirds of our businesses are high-margin, high-growth sectors such as advanced materials, specialty chemicals, performance products, and agricultural sciences. That makes us more competitive, more innovative, and better-positioned for sustained growth over the coming decades.

That's the same kind of transformation I envision for the U.S. manufacturing sector.

I am passionate about manufacturing. I am passionate about these kinds of new, advanced products, about the promise they offer not just to our economic well-being, but to the quality of our lives.

Take one of Dow's latest innovations, the POWERHOUSE solar shingle, for example. In 2009, Dow developed a solar cell so flexible and durable that it could be installed as a shingle on an ordinary roof. This innovation is unique to Dow, and a true game-changer. Today, there are scores of customers who would like to run their homes on solar energy, but they can't, either because it's too expensive, unavailable in their area, or, as is often the case, their homeowners' association won't allow it. No longer. These solar shingles can be installed by any contractor on any home, just about anywhere. I'm proud to report that *Time* magazine named our solar shingles one of the "50 Best Inventions of 2009."

And that's just one example. Here's another one—computer chips. Manufacturers are constantly working to make faster chips,

chips that process more information at less cost. To make these powerful new integrated circuits, layers of chemicals must be applied to them. But there is no margin for error. If one layer is off by just 10 nanometers—one ten-thousandth of the width of a human hair—it can ruin the entire circuit.

When you measure success in terms that small, you're working on the molecular level. So if you're a chip fabricator, you need the right molecule, and you need it to behave the right way. That's our specialty. You wouldn't trust that level of quality to any manufacturer. Performance trumps cost. And it's these kinds of high-performance products that can revive the manufacturing sector. As a nation, we have to evolve from manufacturing only the basics to manufacturing the most advanced products. Companies do this to compete. Nations must, too.

A Tale of Two Nations

The United States cannot afford to fail. To see the potential consequences, we need to look no further than our ally across the ocean. The United Kingdom's manufacturing sector is in even more severe decline than the United States. The British economy was once one of the most productive in the world, with a vibrant manufacturing sector that ushered in substantial economic growth. But even before the most recent recession, the UK manufacturing sector had been lagging behind the rest of the world. Between 1979 and 1982, its output dropped 18 percent. Between 1997 and 2006, a period in which U.S. output grew by 30 percent, British output declined. In the early 1980s manufacturing made up 31 percent of GDP. By 2008, it was just 13 percent. Think of it this way: In 1980, one in four of all UK jobs were in manufacturing. By 2008, that number

was just one in ten. Then the recession hit. Between December 2008 and February 2009, British manufacturing showed its steepest decline since records began being kept.

The consequences of their manufacturing weakness are evident. It is no surprise that the United Kingdom was the last of the major economies to finally come out of the recession. A country without a strong manufacturing base is without the economic tools to spark sustained recovery. Even when consumer spending increases, the goods they are buying are not produced at home. As a result, it's not the British economy their spending is stimulating. It's foreign economies. The United Kingdom is overwhelmed with debt, and in the coming years must make incredibly difficult financial choices. But without manufacturing, the growth they'll need to overcome their challenges will continue to be far out of reach.

This is a bad situation not just for the British, but for the world. When the sixth largest economy finds itself saddled with an economic crisis it cannot solve, the consequences will be felt worldwide.

Here's what we know with certainty: nations that support manufacturing can—and do—thrive. Germany is an extraordinary example of a country with the correct economic priorities. As journalist and manufacturing expert Eamonn Fingleton notes, from 1998 to 2008 Germany went from a trade deficit of $5.9 billion to a trade surplus of $267.1 billion. In that same period of time, the U.S. trade deficit more than doubled, from $224 billion in 1998 to $569 billion in 2008. Even in the depths of recession, the German economy was stable enough to keep unemployment well below 10 percent. To put their manufacturing might in perspective, Germany makes up just 1.2 percent of the world's population, but German industry accounts for 17 percent of global market share.

What's the difference? What is Germany doing that the United Kingdom isn't? According to Fingleton, "The secret to the German system's success is, in large part, a strong national commitment to advanced manufacturing." The German government has a keen sense of the importance of manufacturing, and has made investments to support the sector, even as they transition their economy. That's why manufacturing makes up 20 percent of the German economy, but only 11 percent of the U.S. economy. And it's why, in the race for a competitive long-term future, Germany is far ahead of the pack.

We can be like the United Kingdom. Or we can be like Germany. And it's entirely up to us.

By now it's probably easy to tell that I love manufacturing. I know it has the power to be a transformative force. I come to this topic with a unique perspective. As CEO of one of America's five most global corporations, I have seen firsthand the best practices in place in other countries. We have much to learn from their examples. Because we are one of the world's biggest suppliers to other manufacturing companies, I am also intimately familiar with the plight manufacturers face. They are our customers. And because we are the world's biggest chemical manufacturer, I know personally what needs to be done to keep businesses like ours growing and prospering.

Globally, manufacturing isn't dying. It's evolving. Our opportunity for long-term economic growth depends on our ability to evolve with it.

We know that with the right policies and the right business decisions, manufacturing can work in the United States. Dow just recently opened new plants in Midland. We know that building plants here is still a possibility, and more importantly, we know that

companies like Dow, which have moved jobs overseas, still want to see manufacturing happening here at home.

We have a choice. We can either continue down the path we're on, one that is leading us the way of weakened economic powers. Or we can make decisions and choices today about our future, ones that put us on a path toward new economic prosperity. Failure is not inevitable. But to avoid it, we must act now.