The 3D Printing Revolution:
A Report From the Front Lines

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Reshoring and Other Good News
Reshaping American Manufacturing

By Charlotte Weber

After decades of watching American companies ship jobs to other countries, today we’re seeing many manufacturers and entrepreneurs make a decision to keep their factories and production here in the United States – or even bring jobs back to this country from overseas.

Some people call it “reshoring,” others refer to it as “onshoring.” Whatever term you choose, it’s good news. What’s driving this welcome change? The realization by more and more companies that the costs associated with foreign production no longer make economic sense.

Over the years, China has been successful in wresting away many U.S. jobs. But now the shoe is on the other foot. It’s China that’s seeing jobs disappear.

Today, as Jerry Jasinowski writes in our feature story, “Chinese workers are demanding – and getting – better wages and working conditions.” Jasinowski, former president of the National Association of Manufacturers and later the Manufacturing Institute, reports that wages in China are increasing 15 to 20 percent a year, while the Chinese people are pushing for “greater investment in environmental protection and worker safety.”

Nor does the good news for the U.S. economy and U.S. workers stop there. As Jasinowski notes, reshoring is only one of several positive factors that, as they converge, promise to usher in a new era for U.S. manufacturing.

While oil prices are up, new drilling technology has the United States awash in low-cost natural gas, relied on by many industries not only as a source of energy but also as a feedstock. Writes Jasinowski: “The rock bottom price of natural gas is a real game changer that can only enhance the competitiveness of U.S. manufacturing in the years ahead.”

Beyond this, there’s the introduction of new technology that’s sparking leapfrog advances on the nation’s factory floors. As a result, America workers, who have always been more productive than those in other countries, are becoming even more so.

And the future looks even brighter, as Additive Manufacturing (sometimes called “3D printing”) revolutionizes our traditional concepts of manufacturing.

Because of our determination to stay on the leading edge of manufacturing technology, it was natural that RCBI would venture into Additive Manufacturing. Since we began offering 3D printing in 2009, dozens of clients have used our Design Works labs and taken advantage of our 3D printers to bring their ideas to reality.

Now we’re working as a key partner in the nation’s first Additive Manufacturing Innovation Institute, formed to accelerate the development, integration, evaluation and use of Additive Manufacturing technology for commercial manufacturing.

This issue of CAPACITY touches on a number of these latest trends in manufacturing.

During a recent visit to a flourishing engine-part factory in Ashville, North Carolina, President Barack Obama talked about reshoring and some of the jobs that are coming back to America. “What’s happening here is happening all around the country,” he told those who crowded the plant. “Just as it’s becoming more and more expensive to do business in places like China, America is getting more competitive.”

In this issue, we offer an article by President Obama in which he outlines what he calls four “common-sense steps” to strengthen American manufacturing.

Jeffrey R. Immelt is the Chairman and CEO of GE, a company that’s shown itself a leader in the reshoring phenomenon. Last year it reversed a decision to build a new refrigerator plant in Asia and instead invested $93 million to refurbish a plant in Bloomington, Indiana, saving 700 U.S. jobs. The company then invested another $80 million to revamp a water heater plant in Louisville, Kentucky, rather than ship 400 jobs overseas. Immelt’s article in this issue offers some of his insightful ideas for growing what he calls the “innovation economy.”

And we take a look at Maker: The New Industrial Revolution, a new book by Chris Anderson, the editor of Wired magazine, in which he explores Additive Manufacturing and how it’s poised to change the way we make things.

As always, we welcome your comments and suggestions about our magazine. You may e-mail us at Capacity@rcbi.org.

Charlotte Weber is Director & CEO of the Robert C. Byrd Institute for Advanced Flexible Manufacturing (RCBI).
By Jerry Jasinowski

The bulk of my tenure as president of the National Association of Manufacturers — and later as head of the Manufacturing Institute — coincided with the great kidnapping of major sectors of U.S. manufacturing by foreign competitors, primarily in Asia.

Employment in U.S. manufacturing peaked in 1979 at 19.6 million jobs, and went into decline, dipping below 12 million in January 2010 before finally beginning to move upward again, albeit slowly.

The massive loss of millions of manufacturing jobs quite reasonably provoked a general sense that our country was losing its manufacturing base. In reality, we have remained among the top three manufacturing powers of the world throughout this unprecedented blitz of aggressive foreign competition, at least in terms of the dollar value of production. Lost manufacturing jobs do not necessarily equate to lost manufacturing. The great majority of jobs lost were low skill positions especially vulnerable to low-wage foreign competition. But through the hard times, the United States has retained its lead in advanced manufacturing, a dominance it continues to enjoy.

Today, there is a convergence of trends that suggest persuasively that the cycle of lost manufacturing has played out, and that we are on the brink of a dramatic resurgence of this critical sector that has always been a vital part of our nation’s economy. There are several key factors driving this welcome development.

The most conspicuous of these trends is a dramatic revolution among U.S. manufacturers emphasizing unprecedented advances in productivity and quality. It was a matter of “do or die” and though many companies went out of business, the majority that survived did so through bold innovation, forward looking management and a relentless commitment to lean manufacturing. They are today the leanest, most productive and most competitive manufacturers in the world.

Another factor in the manufacturing comeback is the rapidly changing economic dynamic in our major competitor, China, which over a period of years has employed predatory trade practices to wrest away key sectors of our manufacturing base. There is no great mystery why the Chinese have pursued this tactic. The Chinese are striving to move hundreds of millions of people away from backward farms into a modern industrial infrastructure. This is historically the path that all modern developed nations have trod, and it is working in China just as it worked in Europe and the United States.

But China’s success brings its own problems. Chinese workers are demanding — and getting — better wages and working conditions. The Chinese people are demanding greater investment in environmental protection and worker safety. Wages and benefits in China are increasing 15-20 percent a year while they are virtually stagnant in the United States where labor unions are more focused on job retention than wage hikes. The once distinct cost advantage of Chinese labor is eroding at a quickening pace.

A major part of China’s plan to wrest manufacturing from the United States and other western nations has been manipulation of its currency, the yuan, which has long been a sore point with U.S. manufacturers. But the yuan has been rising steadily against the dollar and most other currencies, and the Federal Reserve’s controversial quantitative easing, driving down the comparative value of the dollar, has reduced the Chinese currency advantage even further.

Oil prices today are three times what they were in 2000, making it more expensive to ship manufactured goods half way around the world. And the significance of the price of oil pales in comparison to that of natural gas that has always been a major component of manufacturing.
Many key manufacturing industries, such as chemicals and plastics, use natural gas both as a source of energy and a feedstock. And today, the United States is awash in low-cost natural gas thanks to new fracking technology that enables us to tap underground sources heretofore beyond reach.

U.S. natural gas today costs $3.55 per million British thermal units compared with $12 in Europe and $16 in Japan, and that disparity will not dissipate any time soon. Also, no other nation has a comparable infrastructure in place to distribute copious amounts of natural gas to where it is needed, or the ample water to extract it from the ground or even the legal framework that encourages development of these resources. The rock bottom price of natural gas is a real game changer that can only enhance the competitiveness of U.S. manufacturing in the years ahead.

But there’s an even more compelling reason for the comeback of U.S. manufacturing and it is an outgrowth of our long-standing leadership in innovation. Today as always the Unites States is on the cutting edge of the technological revolution. We see it on the factory floor where advanced electronics and robotics are sparking leapfrog advances in quality and productivity.

The rapid pace of innovation is fostering a new generation of consumer products. Because of rapid gadget wizardry and consumer demand, the life cycle for many major consumer products such as refrigerators and oven ranges has been shortened from seven years or so to 2-3 years. Production of these new products is more complicated and challenging, and thus harder to manage and control on the other side of the world.

One of our most promising breakthroughs is 3D printing, also known as Additive Manufacturing, that uses digital technology to make a three-dimensional solid object of virtually any shape. Three dimensional printing allows for rapid prototyping, rapid manufacturing and mass customization. Consumers can customize objects using simplified web-based customization software, and order the resulting items as 3D printed unique objects. This revolutionary concept makes it as cheap to create single items as it is to produce thousands, turning the old concept of economy of scale on its ear. Its applications are virtually unlimited — jewelry, footwear, architecture, industrial design, automotive, aerospace, dental and medical, you name it. It dramatically reduces the development time for new products and processes.

“Just as nobody could have predicted the impact of the steam engine in 1750, or the printing press in 1450 or the transistor in 1950,” opined The Economist, “it is impossible to foresee the long-term impact of 3D printing. But the technology is coming, and it is likely to disrupt every field it touches.”

To summarize: The offshoring of U.S. manufacturing at one point had become something of a fad driven not by hard economics, but rather a general sense among management that it was the way the world was moving. Today, reality is catching up and that new reality says that the United States, for a variety of reasons, is now one of the best environments in the world for manufacturing. The future of U.S. manufacturing has never looked brighter.

Jerry Jasinowski, an economist and author, served as president of the National Association of Manufacturers and later The Manufacturing Institute.
President Obama outlines 4 steps to strengthen manufacturing in America

By President Barack Obama

As it’s becoming more and more expensive to do business in places like China, America is getting more competitive and more productive.

After shedding jobs for more than 10 years, our U.S. manufacturers have now added about 500,000 jobs over the past three years. Caterpillar is bringing jobs back from Japan. Ford is bringing jobs back from Mexico. After placing plants in other countries like China, Intel is opening its most advanced plant here in the United States. Apple is starting to make Macs in America again.

So we’re seeing this trend of what we call insourcing, not just outsourcing. And the reason is because America has outstanding workers. We’re starting to produce more homegrown energy, which is driving down our energy costs. And, obviously, we’ve still got the biggest market in the world. And if we try to improve our infrastructure a little bit more, then we’re going to be even that much more competitive.

Now, I want to be honest with you. We’re not going to bring back every job that’s been lost to outsourcing and automation over the last decade. It used to be everything was done manually. Now plants have computers and workers punch in stuff. So it’s changed, and that means that companies can just produce a lot more with fewer people.

But there are things we can do right now to accelerate the resurgence of American manufacturing.

NUMBER 1 — We can create more centers for high-tech manufacturing in America. Last year, my administration created our first manufacturing innovation institute. We put it in Youngstown, Ohio, which had been really hard-hit when manufacturing started going overseas. And so you have a once-shuttered warehouse — it’s now a state-of-the art lab where new workers are mastering what’s called 3D printing, which has the potential to revolutionize the way we make everything. That’s the future. and there’s no reason that those same kinds of projects can’t take root in other cities and towns.

So I’ve announced the launch of three more institutes. And I’m calling on Congress to help us set up 15 institutes — global centers of high-tech jobs and advanced manufacturing around the country.

NUMBER 2 — The second thing we need to do is make our tax code more competitive. Right now, companies get all kinds of tax breaks for moving jobs and profits overseas, but companies that stay here get hit with one of the highest tax rates in the world. That doesn’t make any sense. So what I’m proposing is that we reform our tax code, stop rewarding businesses that ship jobs overseas, reward companies that are creating jobs right here in the United States of America. That makes sense.
NUMBER 3 — If you’re a manufacturing town, especially one that’s taken a hit — that’s seen a company close up shop or a plant shut down — I want to partner with local leaders to help you attract new investment. Because once that investment starts coming in, things can start turning around. And that means infrastructure gets modernized and research facilities get built, and suddenly a community that was knocked down is getting back up, and they’re attracting new manufacturers who want to come and expand and hire.

NUMBER 4 — We’ve got to help our workers get the training to compete for the industries of tomorrow. No job in America should go unfilled because somebody doesn’t have the right skills to get that job — nobody. If there is a job open, we should train those folks right away, so that they can do the job. And that’s why I’m proposing a national goal of training 2 million Americans with skills that will lead directly to a job.

So those are four common-sense steps that we can take right now to strengthen manufacturing in America. There’s no magic bullet here. It’s just some common-sense stuff. People still have to work hard. Companies still have to make good products. But the point is, is that if we can just do a few things, then over time what happens is we start rebuilding our manufacturing base in a way that strengthens our economy as a whole.

So that’s our story. That’s the American story. We don’t give up. We get up. We innovate. We adapt. We learn new skills. We keep going.

This article is excerpted from a speech President Obama delivered Feb. 13 at the Linamar Corp. plant in Ashville, North Carolina. A Canadian company, Linamar manufactures engine blocks for trucks and heavy equipment. It moved into a former Volvo plant in 2011 and has hired 160 workers. It says it plans an eventual workforce of 650.
Once upon a time, ambitious young people with a knack for math and science went to work in manufacturing. They designed planes, computers and furniture, figured out how to lay out an assembly line, helped to make new cars faster and refrigerators more efficient, pushed the limits of computer chips, and invented new medicines. But, as the role of manufacturing diminished in advanced economies, the brightest talents tended to gravitate to finance and other service fields that were growing rapidly — and paying well.

But here’s some news: Global manufacturing has the potential to stage a renaissance and once again become a career of choice for the most talented.

Of course, any manufacturing rebound in the advanced economies will not generate mass employment; but it will create many high-quality jobs. There will be more demand for software programmers, engineers, designers, robotics experts, data analytics specialists and a myriad of other professional and service-type positions. In some manufacturing sectors, more such people may be hired than will be added on the factory floor.

Exploding demand in developing economies and a wave of innovation in materials, manufacturing processes, and information technology are driving today’s new possibilities for manufacturing. Even as the share of manufacturing in global Gross Domestic Product has fallen — from about 20 percent in 1990 to 16 percent in 2010 — manufacturing companies have made outsized contributions to innovation, funding as much as 70 percent of private-sector R&D in some countries. From nanotechnologies that make possible new types of microelectronics and medical treatments to Additive Manufacturing systems (better known as 3D printing), emerging new materials and methods are set to revolutionize how products are designed and made.

But, to become a genuine driver of growth, the new wave of manufacturing technology needs a broad skills base. For example, it will take many highly-trained and creative workers to move 3D printing from an astounding possibility to a practical production tool.

Consider, too, the challenges of the auto industry, which is shifting from conventional, steel-bodied cars with traditional drive trains to lighter, more fuel-efficient vehicles in which electronics are as important as mechanical parts. The Chevrolet Volt has more lines of software code than the Boeing 787. So the car industry needs people fluent in mechanical engineering, battery chemistry and electronics.

Manufacturing is already an intensive user of “big data” — the use of massive data sets to discover new patterns, perform simulations, and manage complex systems in real-time. Manufacturing stores more data than any other sector — an estimated two exabytes (two quintillion bytes) in 2010. By enabling more sophisticated simulations that discover glitches at an early stage, big data has helped Toyota, Fiat and Nissan cut the time needed to develop new models by 30-50 percent.

Manufacturers in many other branches are using big data to monitor the performance of machinery and equipment, fine-tune maintenance routines, and ferret out consumer insights from social-media chatter. But there aren’t enough people with big-data skills. In the United States alone, there is a potential shortfall of 1.5 million data-savvy managers and analysts needed to drive the emerging data revolution in manufacturing.

The shift of manufacturing demand to developing economies also requires new skills. A recent McKinsey Global Institute survey of multinationals based in the United States and Europe found that, on average, these companies derive only 18 percent of sales from...
developing economies. But these economies are projected to account for 70 percent of global sales of manufactured goods (both consumer and industrial products) by 2025. To develop these markets, companies will need talented people, from ethnographers (to understand consumers’ customs and preferences) to engineers (to design products that fit a new definition of value).

Perhaps most important, manufacturing is becoming more “democratic,” and thus more appealing to bright young people with an entrepreneurial bent. Not only has design technology become more accessible, but an extensive virtual infrastructure exists that enables small and medium-size companies to outsource design, manufacturing, and logistics. Large and small companies alike are crowd-sourcing ideas online for new products and actual designs. “Maker spaces” — shared production facilities built around a spirit of open innovation — are proliferating. And yet, across the board, manufacturing is vulnerable to a potential shortage of high-skill workers.

Research by McKinsey finds that the number of college graduates in 2020 will fall 40 million short of what employers around the world need, largely owing to rapidly aging workforces, particularly in Europe, Japan, and China. In some manufacturing sectors, the gaps could be dauntingly large. In the United States, workers over the age of 55 make up 40 percent of the workforce in the manufacturing of agricultural chemicals and more than one-third of the workforce in ceramics. Some 8 percent of the members of the National Association of Manufacturers report having trouble filling positions vacated by retirees.

Indeed, when the National Association of Manufacturers conducted a survey of high-school students in Indianapolis, Indiana (which is already experiencing a manufacturing revival), the results were alarming: only 3 percent of students said that they were interested in careers in manufacturing. In response, the NAM launched a program to change students’ attitudes. But not only young people need persuading: surveys of engineers who leave manufacturing for other fields indicate that a lack of career paths and slow advancement cause some to abandon the sector.

Manufacturing superstars such as Germany and South Korea have always attracted the brightest and the best to the sector. But now manufacturers in economies that do not have these countries’ superior track record must figure out how to be talent magnets. Manufacturing’s rising coolness quotient should prove useful, but turning it into a highly sought-after career requires that companies in the sector back up the shiny new image with the right opportunities — and the right rewards.

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West Virginia Exports Again Set Growth Record

West Virginia exports were up in 2012 – for the third consecutive year.

Statistics from the U.S. Department of Commerce show the state’s exports grew from $9 billion in 2011 to $11.3 billion in 2012. The statistics show 2012 saw West Virginia businesses export to 136 countries. “Last year, West Virginia’s exports grew by 25 percent, surpassing the national growth rate of 4.6 percent,” Gov. Earl Ray Tomblin said in a news release. “Exports are a valuable contributor to our state’s economic growth and stability. While coal continues to be our traditional strength, our top exports also included manufactured products such as plastics, chemicals, machinery and components for medical, automotive and aerospace applications.”

The state’s coal exports grew by about 40 percent, increasing from $5.3 billion in 2011 to $7.4 billion in 2012. The markets for coal with the largest growth were Japan and China, which recorded huge increases in their purchases. Coal sent to Japan went from $29 million in 2011 to $395 million in 2012. China’s purchases of West Virginia coal went from $83 million in 2011 to $567 million in 2012.

The state’s second largest export sector was plastics, reaching more than $1 billion for the second year in a row. Manufacturing exports also increased. The biggest 2012 customer for West Virginia’s non-coal exports was Canada, with purchases valued at $1.3 billion. The second and third best customers for the state’s non-coal exports were China, with purchases of $370 million, and Japan, with $352 million.

The International Division of the West Virginia Development Office (WVDO) offers a broad range of export promotion services to the state’s small and medium-sized businesses. For information on West Virginia trade shows, trade missions and other services, visit www.worldtradewv.com.
Growing the Innovation Economy is Key to Manufacturing’s Future

By Jeffrey R. Immelt

America can turn a slow recovery into a strong comeback, one that grows our economy and firmly reestablishes our country as a powerhouse of ideas and production. One of the keys — and what will determine the winners and losers of an exciting new era — is our willingness and ability to lead the next “big waves” of productivity.

There are four new drivers of productivity, and success in each depends on the technology and talent we develop.

The first is how shale gas is changing the energy debate and the balance of energy power. The second is the Industrial Internet — owning and connecting the analytical layers around industrial products in order to improve performance and efficiency.

Next is speed and simplification: the only way to serve our customers better is by working faster and smarter.

The last driver is advanced manufacturing. Manufacturing excellence, forgotten for too long, is once again a competitive advantage.

Manufacturing is still an essential driver of the U.S. economy, employing about 12 million people in America, or 9 percent of the workforce. It generates $1.7 trillion in value each year, and manufactured goods account for 53 percent of all U.S. exports. Seventy percent of private sector spending in research and development in the U.S. comes from manufacturing companies. Manufacturing also has an outsized impact on our economy as a whole. It is responsible for roughly 7 million American jobs in other industries, and every dollar in manufacturing sales generates $1.34 in output from other sectors.

Despite all of this, companies have historically outsourced critical capabilities in their supply chain and focused too much on cheap labor rather than speed, innovation and market access. As a nation, short-term gains fooled us into believing that we could build a sustainable economy solely based on service jobs. We also didn’t fully appreciate the negative effect that poor labor/management relations and eroding “systems of competitiveness,” from the regulatory environment to education, had on our ability to innovate and grow the economy.

Today, we can reverse these trends. Indeed, advanced manufacturing — both imbedding technology into products and processes and creating the highly skilled workforce that can support these efforts — and other new innovations in manufacturing are changing what we make, where and how we make it, and even who makes it. Large or small companies that invest in their own capabilities and “own” or control a local supply chain have a competitive advantage as they develop their next breakthrough.

GE Aviation is a great example. To date, we’ve manufactured jet engine components mostly by casting, stamping and cutting steel and alloys. Now, through 3D printing, or Additive Manufacturing, we can “print” complex parts layer by thin layer. Our newest jet engines like the CFM LEAP, a joint venture with France’s Snecma, will have printed combustion system components and other parts inside, reducing engine weight and saving our customers money.

There are other examples across our businesses. Researchers in our Global Research Center labs in Niskayuna, New York, invented a new sodium-based battery technology that stores nearly four times as much energy as the lead-acid batteries used today. GE teams also designed an advanced manufacturing process to build the battery efficiently in Schenectady, just a few miles away, where our Energy Storage business is headquartered.

Now is the time to bring these and other efforts to scale, changing both the way we build complex machines and the entire competitive landscape. The rise of analytics and software in the industrial world only multiplies the opportunity in front of us. America must capitalize.

We are on the right path, but to lead in manufacturing and to compete and win globally, we must:

■ Make manufacturing jobs a priority: Job creation and manufacturing leadership require a sense of urgency and a sense of prioritization. Around the world, leaders unabashedly support their manufacturing sector. The United States must do the same.

■ Recommit to research and development for the next generation of technology: The American economy is built on innovation. But, research and development spending hovers at around just 2 to 3 percent among U.S. companies. To pioneer the growth of nascent technologies, including Additive Manufacturing,
and to accelerate the economic recovery, we must make a stronger commitment to pursue new ideas and find breakthroughs.

**Focus on people:** The American workforce is unmatched; we can compete with anyone. But we can’t divide labor and business. We can’t shut our doors to the most creative and inventive people in the world, whether they are born and raised here, or come to our shores from elsewhere. And we can’t deny our workers the skills today’s economy demands; in fact, our efforts must start with revitalized math, science and engineering instruction during the K-12 years and continue through job training.

**Nurture relationships between big and small businesses to facilitate innovation:** Innovation happens everywhere. At GE, we partner with small and mid-size businesses throughout the supply chain to create a culture of constant learning, in which game-changing ideas can be brought to scale. At the same time, we can learn from these partners and create a more entrepreneurial environment and a “start-up” culture.

**Grow exports:** Open markets and exports are critical to the U.S manufacturing sector. The United States must do more to open markets abroad for American goods while maintaining the openness of its own market. We can do this with unilateral, bilateral and multilateral trade-expansion initiatives. Today, most of GE’s revenues come from outside the United States. GE exports about 80 percent of the turbines we make in Greenville, South Carolina. We sell in 140 countries. The marketplace is global, and our ability to reach customers around the world supports American jobs.

**Improve our “systems of competitiveness”:** We must create an environment where we cultivate systems that enable growth and competitiveness. That means regulatory reform — for instance, aligning state and federal regulations so America can take advantage of the natural gas boom. It also means having the fiscal certainty that gives businesses the confidence to make long-term decisions. Gridlock over the budget, debt ceiling, meaningful entitlement reform and taxes impedes growth and investment.

The United States cannot be afraid to lead. The ability for highly skilled workers to integrate technology into products and processes has us on the cusp of a productivity revolution. If we make the most of this moment, we will create new jobs and new businesses. We will accelerate economic growth, renew prosperity and together build a world that works better.

Jeffrey R. Immelt is the Chairman and CEO of GE. His article first appeared on www.ideaslab.com, a partnership between GE and Atlantic Media Strategies.
The New Industrial Revolution:  A Report From the Front Lines

By James E. Casto

A new book by a best-selling writer places its readers on the front lines of the next resurgence of the American manufacturing industry and the 3D printer revolution.

Chris Anderson is the editor in chief of Wired, an award-winning monthly magazine and on-line publication that reports on how new technology is changing the world we live in. In The Long Tail, a 2006 bestseller, Anderson explored the business strategy of selling small quantities of a great many hard-to-find items as contrasted with selling vast quantities of a single item. Amazon.com, he noted, has to a great extent successfully built its business on this strategy. Yes, the on-line bookseller sells all the popular books, but it’s also the best place to locate that impossible-to-find title you’ve been looking for.


By way of background, Anderson shares with readers the story of his maternal grandfather, Fred Hauser, a skilled machinist who in 1926 emigrated from Switzerland to Los Angeles, where he got a job working on recording technology for MGM Studios. “But Hauser,” he writes, “was more than a company engineer. By night, he was an inventor. He dreamed of machines, drew sketches and then mechanical drawings of them, and built prototypes.”

Hauser converted his garage into a well-equipped machine shop so he could turn his inventive dreams into reality. He tinkered with various projects and then, in the 1940s, devised an automaker sprinkler system that homeowners could use to water their lawns. After he had built his prototype and tested it on his own lawn, he applied for a patent.

“And there,” Anderson writes, “was where the limits of the twentieth century industrial model were revealed. … My grandfather could invent the automatic sprinkler system in his workshop, but he couldn’t build a factory there. To get to market, he had to interest a manufacturer in licensing his invention.”

Hauser’s story had a happy ending. He was able to interest a manufacturer, who brought his sprinkler to market and paid him royalties over the next several years. “But,” as Anderson notes, his “was a one-in-a-thousand success story; most inventors toil in their workshops and never get to market.”

Anderson argues that his grandfather’s story might have an even happier ending if he were born in 1998, rather than 1898. Today his grandfather would still be tinkering in his workshop, but how different that workshop would be. A computer and an Internet connection would open up worlds that surely Fred Hauser never dreamed of.

His T-square, triangle and other mechanical drawing tools that he once used to turn his rough sketches into working drawings are gone, replaced by computer software that generates digital design files. His drill press, band saw, grinder and metal lathe now gather dust in the corner of his shop. No longer are they needed to fashion blocks of metal into prototypes. Instead, a 3D printer uses a digital design file to create a prototype object in a matter of hours, not days or weeks.

And, best of all, today’s incarnation of Anderson’s grandfather isn’t just an inventor, he’s an entrepreneur. No longer does he have to beat the bushes, looking for a manufacturer willing to license his ideas. Now he can put them into production himself. He can upload his design files to companies that can make anything from...
Today, big companies such as Ford Motor Co. are using digital design files and 3D printers to craft prototypes of new auto parts, shaving the time required from months to weeks. In doing so, they're using equipment that costs tens of thousands of dollars.

But Anderson says the real excitement in what's happening isn't in its impact on big manufacturers such as Ford. It's in the world of opportunity it opens for individuals who like to tinker around in their basement or garage workshop. Anderson sees all the pieces coming together for a new era of micro-manufacturing.

Today, companies such as MakerBot are selling mass-market 3D printers for as little as $2,500 each - a price that puts them well within the budgets of small businesses and technology-minded enthusiasts. The future products that will come from those printers will be limited only by the imagination of the individuals using them, says Anderson. He predicts the “maker revolution” will have much the same kind of impact on society as the introduction of the personal computer and the Internet. “The introduction of a digital manufacturing model to the general public means ... the democratization of technology.”

Within the next 10 years, he predicts, this country is going to see an explosion of micro-factories and manufacturing startups that will create thousands of badly needed new jobs and firmly establish the United States as the world leader in a new kind of manufacturing, one based not on low-cost labor but on innovation.

Meanwhile, Anderson isn't just writing about the unfolding maker revolution. He's an active participant in it. He's the co-founder of 3D Robotics, a multimillion-dollar robotics company with plants in California and Mexico that manufactures aerial drones. He also presides over DIY Drones, an on-line information community.

Anderson's fast-growing drone business had its beginning in a backyard project he undertook with his youngsters. From that modest start, things took off rapidly in just a few short years. “If I can do it, knowing so little about the subject matter, I feel anybody could do it,” he says.

Surely his inventive grandfather would be amazed.

James E. Casto is associate director of public information at the Robert C. Byrd Institute for Advanced Flexible Manufacturing (RCBI). He can be reached at jcasto@rcbi.org.
Italian company to build $9 million plant in Weirton

An Italian company, Pietro Fiorentini USA, has announced plans to build its first U.S. manufacturing facility in Weirton. The $9 million plant in the Three Springs Business Park is expected to create up to 41 jobs during the initial phase and up to 150 when fully operational. The new manufacturing facility will produce components for the treatment of shale oil and gas. Construction of the plant is expected to start this summer.

Conley Fabrication announces $1.5 million expansion

Just two years after starting up, truck bed fabricator Conley Fabrication is expanding. The company is building a new 45,000-foot facility outside of Mineral Wells near Interstate 77. The new building and contents represent a $1.5 million investment. After truck bed manufacturer Benson International closed, Conley Fabrication was founded by former employees. Conley currently occupies and employs 10 people. When the new shop is opened, the company expects to double its workforce.

NGK Spark Plugs expanding, adding jobs

NGK Spark Plugs (U.S.A.) announced plans to expand its oxygen sensor manufacturing facility, its spark plug production capability and its staffing level at its Sissonville campus. An 8,000-square-foot addition to the sensor plant will have a new line dedicated to the production of a more technologically advanced sensor. In addition, the spark plug facility on the same campus will install a new assembly line to produce a different style of spark plug. Both projects are expected to be completed during 2013. NGK expects these improvements will create 34 new jobs by 2014.
Antero building $16 million headquarters

Ground has been broken for two new buildings to house the West Virginia drilling headquarters for Denver-based Antero Resources. The buildings in White Oaks Business Park in Bridgeport will total 50,000 square feet and represent a combined investment of $16 million. The facilities are scheduled for completion by July 2013. Ultimately, the Antero complex could house up to 500 workers and contractors. Antero is an independent oil and natural gas company active in Marcellus Shale drilling.

Walker Machinery goes underground

Mine equipment dealer Walker Machinery is expanding into the underground mining business. For years, Walker, with headquarters in Belle, has been a Caterpillar dealer for surface mining equipment. Now Walker and Louisville-based Whayne Supply have formed Whayne-Walker Underground Mining and purchased Caterpillar's Bucyrus underground mining equipment distribution and support business for their territories. Whayne and Walker are authorized Cat dealers in Kentucky, southern Indiana, southeastern Ohio and portions of West Virginia. The new business is hiring 38 former workers from Caterpillar's Bucyrus equipment division.

Summit Construction has $50 million impact

Construction of the Boy Scouts of America's Summit Bechtel Family National Scout Reserve in Fayette County has produced an economic impact of more than $50 million in wages and materials alone. To date, $16 million in materials have been purchased in West Virginia. During the 2013 National Scout Jamboree, 40,000 Scouts and Scouters will travel to West Virginia to attend or staff the week-long event. The Jamboree is scheduled July 15-24.
MIT: American Manufacturing Has Lost Ability To Put Innovative Products Into Full Production

Structural changes in U.S. industry over the past 30 years caused primarily by the financial sector’s insatiable quest for profits have left “gaping holes” in the American system of scaling up new technologies to large-scale production, according to preliminary findings from a study conducted by 20 professors and their students at MIT.

“The fact is that resources that used to be there as public goods — things that companies could draw upon if they did not create those resources themselves — have dried up and shrunk and moved away,” says Suzanne Berger, MIT professor of political science and co-director of MIT’s Production in the Innovation Economy (PIE) project. “No company, not even the largest U.S. multinational, can create in-house all of the resources it needs to scale products up, and this is all the more true of startups and main-street manufacturers.”

In a “fact-based” study of 255 companies in the United States, Europe and China, the MIT professors found that the United States has — for the most part — lost the ability to transition a new product or product innovation to commercial production. The problem not only persists among America’s best manufacturers, but is even more pronounced among venture-capital backed firms trying to commercialize innovative ideas.

Unlike their competitors in Germany and China, American manufacturers and innovators are “home alone” when it comes to scaling up a product or innovation to commercial production, says Berger. Adds the Production in the Innovation Economy’s interim report: “It’s not just that factories stand empty and crumbling: It’s that critical strengths and capabilities have disappeared that once served to bring new enterprises to life.”

In its two-year study, MIT decided to look from the bottom up on the system of new product commercialization and production. They talked with company executives about how they trained workers, found capital, invested in equipment and identified suppliers needed to manufacture a new product. The question MIT intended to answer was this: “We know the United States is strong in innovation, but can it bring these innovations to market?”

Among its conclusions:

- “There are many serious reasons to worry about the fate of manufacturing in the United States.”
- “Financing, capabilities, and customers and suppliers pull technology development abroad.”
- “The most urgent challenge for U.S. innovation and production is to rebuild the capabilities in the industrial ecosystem.”

The MIT cross-disciplinary team studied a group of 150 startup companies developing physical products that spun out of MIT laboratories from 1997 to 2008. They visited growing manufacturing companies in Ohio, Massachusetts, Arizona and Georgia. And they conducted interviews at 30 large U.S. multinationals. They compared them to 32 similar companies in Germany, 36 in China and 10 from other countries.

In looking at the largest firms, MIT found that the American industrial landscape has changed dramatically due to a financial system that forced them to focus on core competencies. “Globalization and low-cost imports from China have made a difference, but we believe the real change took place in the 1980s when you began to see scaling down and changes in financial markets that made it very desirable to move your production capabilities out of your own four walls and become an asset-light company,” says Berger.

This trend “has left gaping
holes in the industrial ecosystem that have started to have a huge impact” on the American economy, says Berger. “A lot of good came from those changes: the fact that you can access production capabilities that you don’t have to create in-house, even if they are overseas. That should allow innovation to come to market more rapidly and in some cases it has, but we did not have the accompanying public policy changes that would have allowed much of our manufacturing economy to have benefited from these changes.”

The danger now, says the MIT study, “is that as U.S. companies shift the commercialization of their technologies abroad, their capacity for initiating future rounds of innovation will be progressively enfeebled. . . Looking even further down the food chain beneath the companies to the laboratories that can generate innovations in the first place, looking at the university laboratories that are the terrain we know best, we saw reasons to fear that the loss of companies that can make things will end up in the loss of research that can invent them.”

The companies that spun out of MIT laboratories did well through their first 10 years, securing additional rounds of funding from venture capitalists. It was only at the point when they were ready to move to commercial scale that they couldn’t find the resources to scale up production, says Berger.

The point at which a company would start generating the biggest payoff with growing revenues and profits — after investing in plant and equipment and trained workers — is not happening in the United States.

The same was true of the fastest growing small and medium-sized manufacturing companies in the United States. “When we compared the main street manufacturers to what we were seeing in Germany, we realized that even though these were very innovation firms, they just weren’t growing fast enough,” says Berger. “The level of growth of their profits, the speed in which they could bring a product to market, the increase in the jobs that they could create seemed to be sub-optimal and we came to realize that the problem is that they have to depend entirely on their own internal resources.”

In Germany, MIT found not only “legacy resources, but also access to a rich and diverse set of complementary capabilities in the industrial ecosystem,” says the interim report. These include “suppliers, trade associations, industrial collective research consortia, industrial research centers, Fraunhofer Institutes, university-industry collaboratives, (and) technical advisory committees.” While Germany has almost 300 different organizations involved in these types of programs, there are “thin and shrinking resources available to U.S. manufacturers across much of the country.

In China, MIT professors found firms “that excel in scale-up to mass manufacturing not because of low-cost labor, but because of their ability to move complex advanced product designs into production and commercialization.” American firms are drawn to these companies because of their “specific capabilities in knowledge-intensive scale up [that] involve reverse engineering and re-engineering a mature product to make it more rapidly and efficiently; making designs into new-to-the-world products and processes; and indigenous product innovation.”

It is now imperative for the United States to create a similar industrial ecosystem that includes organizations involved in risk reduction, risk sharing, risk pooling, “bridging” activities and training, according to MIT. Examples include the recently created National Additive Manufacturing Innovation Institute.
Cuts in Federal Space Budget Could Put Many U.S. Companies Out of Business

A substantial percentage of companies that specialize in the space industry are on the brink of extinction. According to the initial findings of an industry survey conducted by the federal government of 1,087 companies in the space supply chain, 38 percent said they would be insolvent if the government’s space budget declines precipitously. Forty-six percent of the companies that are doing work for the space programs run by the National Reconnaissance Office said they would go out of business if there was a deep cut in that agency's budget.

Federal agencies that have space programs are vulnerable to the loss of important technologies and services. Those who responded to the survey identified 2,667 unique critical suppliers that supported key manufactured goods and services for the U.S. space industry. Of these, 37 percent were either from sole source suppliers (14 percent) or single-source suppliers (23 percent).

The detailed survey conducted by the Commerce Department’s Bureau of Industry and Security in collaboration with the U.S. Air Force, NASA and the National Reconnaissance Office will provide agencies with pinpoint accuracy of what is happening down at least five tiers in the space supply chain. “We can see what is currently going on with these companies with their financial health and expenditures and potential impacts if there are programmatic or budget cuts,” says a Commerce Department official involved in the analysis. “What we are trying to say to our partner agencies is you have 203 respondents that might lose their solvency or viability. You need to start looking at who they are and what they make, what suppliers support them and who they support in the industrial base to find these critical nodes, these potential weak points in the industrial base, not just for particular programs but the agency interdependency.”

Already, 19 percent of the companies responding to the Commerce Department survey (206 out of 1,087) said they have already been somewhat or significantly impacted by declining demand from the U.S. government for space-related products and services. One small company said cuts to government space programs have “fundamentally changed the outlook for several of our clients.”

U.S. Manufacturing Wages Stuck in Neutral

Manufacturing workers in the United States are not close to being the highest paid in the world. The average hourly compensation for a manufacturing worker in the United States in 2011 was $35.53, below what workers make in 17 other developed countries.

Compared to foreign rivals, American manufacturing workers are also not experiencing much by way of wage increases. Of the 34 countries that the Bureau of Labor Statistics’ International Labor Comparisons (ILC) program follows, U.S. manufacturing employees ranked in 33rd place for the annual percent change in hourly compensation costs in 2011. The only country whose manufacturing workers received less of an increase in pay and benefits was Greece.

Moreover, over the course of the past 16 years, manufacturing workers in every country save for one (Taiwan) experienced large gains in compensation compared to American workers, “improving U.S. cost competitiveness,” says the ILC program.

Manufacturing employers in Norway had the world’s highest compensation rates for their workers: $64.15 per hour, far above the burden for U.S. manufacturing employers. Switzerland ($60.40), Belgium ($54.77), Denmark ($51.67) Sweden ($49.12) and Germany ($47.38) had workers earning far more than those in the United States. Even workers in Ireland, Canada, Italy and Japan receive greater compensation than Americans.

Compared to other countries, U.S. employers are not very generous with hourly pay, which averaged $23.70 in 2011, compared to Switzerland at $39.92, Denmark at $39.15, and Australia at $32.63.
U.S. Manufacturing generates $1.7 trillion in value each year.

$1.7 trillion

Manufacturing employs about 12 million people in America, or 9 percent of the nation’s workforce.

ManuFacts

53%

Manufactured goods account for 53 percent of all U.S. exports.

70%

70 percent of private sector spending in U.S. research and development comes from manufacturing companies.

49,100

Manufacturers in West Virginia employ 49,100 workers, or 6.6 percent of the state’s workforce.

West Virginia is home to 1,334 manufacturing establishments.

1,334

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