WILLIAM B. BONVILLIAN

Donald Trump's Voters and the Decline of American Manufacturing

The United States ignores the manufacturing sector at the expense of its innovation system and working class communities. The political ramifications could be enormous.

DIEGO RIVERA, South wall (detail), *Detroit Industry* murals, 1932–33.

Who are Donald Trump's voters? What do they want? Observers call them angry, but anger has root causes and grievances. A December 2015 *Washington Post*-ABC News poll tells what we already sensed—his supporters tilt toward male, white, and poor. Other polls tell us the most important single predictor for Trump voters is that they didn't go to college. A study from the Brookings Institution's Hamilton Project informs this picture: full-year employment of men with a high school diploma but without a college degree dropped from 76% in 1990 to 68% in 2013; the share of these men who did not work at all rose from 11% to 18%. Although real wages have grown for men and women with college degrees, they have fallen for men without college degrees: the median income of these men fell by 20% between 1990 and 2013. This is not the American Dream. A Rand survey unearths another key feature: voters who agreed with the statement "voters like me don't have any say about what the government does" were 86% more likely to vote for Trump than were voters who disagreed. They feel they have no voice and no power. These voters also resent trade agreements and immigrants competing for jobs, and more come from areas where racism historically has been more prevalent.

So there are a number of strands to Trump's support but the economic elements tell us an evolving story that hasn't been fully faced. Americans in the postwar era developed a myth of classlessness—almost everyone was middle class. Development during this period of an innovation-based growth model and expansion of mass higher education made the nation rich, enabling everyone to rise and fostering expectations and a dream of egalitarian democracy. Now Donald Trump wakes up society to see a class of Americans cut adrift from the middle class and in tough economic straits.

Part of the story is education. Higher education since the industrial revolution has become increasingly tied to economic well-being. Economists Claudia Goldin, Lawrence Katz, and David Autor argue that the continuing technological advances in industry require an ever-increasing level of technological skill in the workforce. The United States created a system for public mass higher education through the Land Grant College Act in 1862, then enlarged access after World War II with the GI Bill, perhaps the nation's most important social legislation ever. For more than a hundred years, the education curve stayed ahead of the technology implementation curve, but starting in the 1970s, the higher education graduation rate began to stagnate while the required workforce skills continued to rise. These economists argue that these divergent trends are a major cause of growing US income disparity. Whereas the US upper-middle class was able to keep ahead of the technological skill curve, increasing its graduation rate, the lower-middle and lower classes were not. The upper-middle class rode

Diego Rivera

The *Detroit Industry* murals by prominent Mexican artist Diego Rivera pay tribute to Detroit's manufacturing base and labor force. In the first half of the twentieth century, Detroit was the center of America's most important industry—automobile manufacturing—and it was a symbol of modernity and the power of labor and capitalism. Commissioned by Edsel Ford, then president of the Ford Motor Company, Rivera completed the 27-panel work at the Detroit Institute of Art in 1933. It is considered the finest example of Mexican mural art in the United States, and Rivera thought it his most successful work. A leader of the Mexican mural movement, Rivera sought to bring art to the masses through large-scale public works, which often featured stylized representations of the working classes and indigenous cultures of Mexico. Rivera saw industry as the indigenous culture of Detroit.

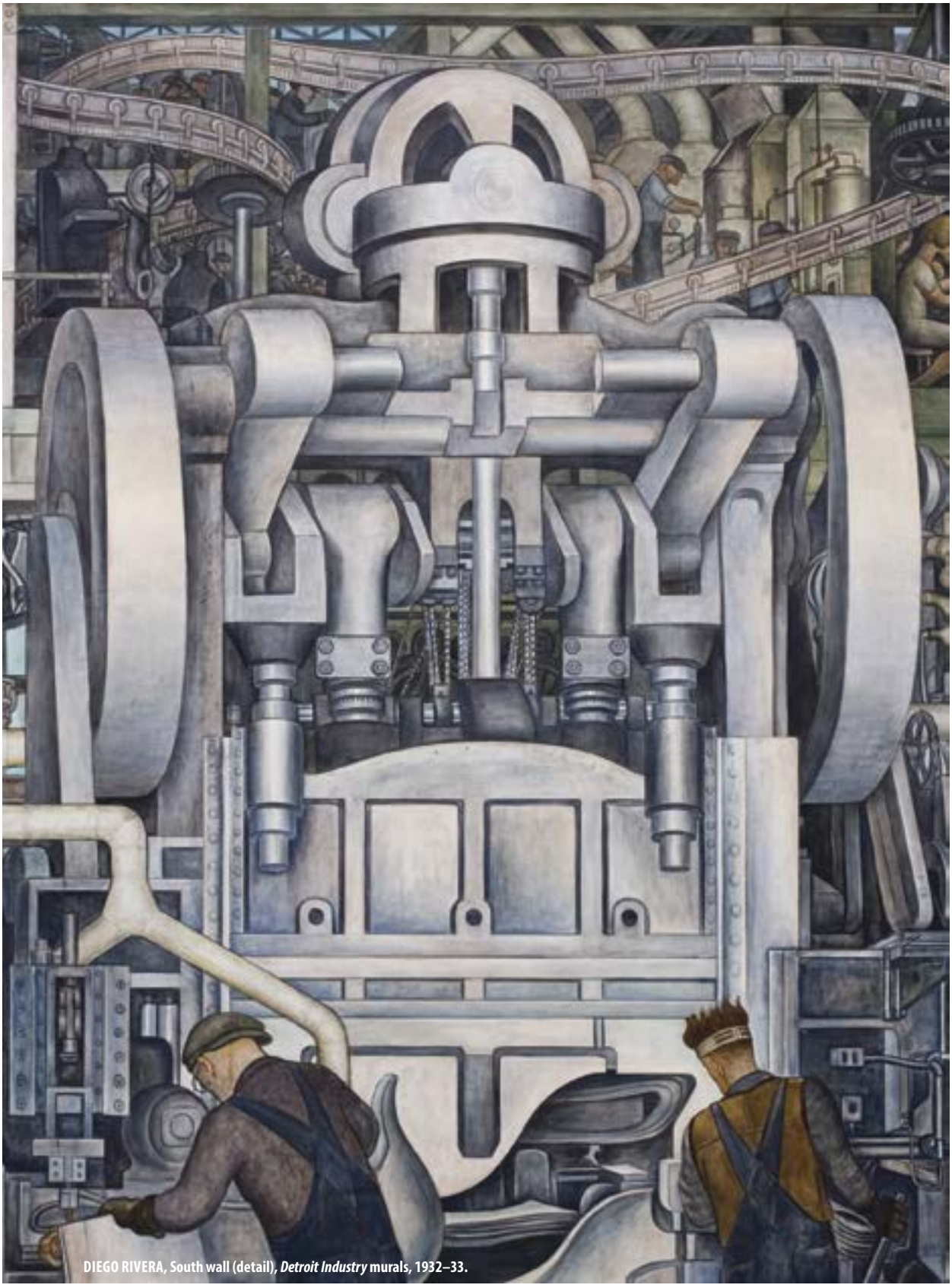
Depicting Detroit industry as a whole, with particular emphasis on the automobile industry, the murals highlight the duality—constructive/destructive, organic/mechanistic—of industry and technology. The courtyard featuring the murals is aligned on the east/west/north/south axis, and Rivera used this orientation symbolically. On the east wall, the direction of sunrise and beginnings, he depicts a baby in the bulb of a plant framed by plowshares and two women holding grain and fruit. Rivera's imagery symbolizes fertility and bounty, and he references early agricultural technology. The north and south walls, which comprise the largest parts of the murals, depict the manufacture of the 1932 Ford V-8 at the company's River Rouge plant. He drew upon his background in cubism, showing multiple angles simultaneously, to depict the bustling activity and relationship among processes taking place on the factory floor. On the west wall, the direction of sunsets and endings, Rivera continues the theme of the development of technology that he began on the east wall with depictions of aviation, shipping, and energy production. A passenger plane and military bombers clearly represent the benefits and dangers of technology, and depictions of a hawk and dove underscore this theme. Rich with symbolic meaning, the murals are at once an enthusiastic celebration of and a cautious warning against science, technology, and industry.

When the murals were unveiled, they sparked a major controversy. Some critics claimed that they were sacrilegious, others didn't like images of the working class featured in such a prominent place, and still others were upset at the sum the artist was paid at the height of the Great Depression. The Detroit City Council even considered a vote to whitewash the murals. Today, the murals are considered one of the most important modernist works of the twentieth century and were given National Historic Landmark Status in 2014.

A virtual tour is available online at www.dia.org/diego/tours.html . The tour is also available as a free downloadable iPad app.

—Alana Quinn

DIEGO RIVERA, North wall (detail), *Detroit Industry* murals, 1932–33.



DIEGO RIVERA, South wall (detail), *Detroit Industry* murals, 1932–33.

this technological advance, earning a wage premium and leaving the other classes behind. Education is thus an important story helping to explain growing economic inequality and the disenchantment among Trump supporters.

But lurking behind this trend is a story about US manufacturing. The United States didn't take manufacturing seriously in recent decades because a series of well-established economic views reassured us that declines in manufacturing were more than offset by gains elsewhere in the economy. The nation was losing manufacturing jobs because of major productivity gains; the production economy would naturally be replaced by a services economy; low-wage, low-cost producers must inevitably displace higher-cost ones; don't worry about loss of commodity production, the country will retain a lead in producing the high-value advanced technologies; the benefits of free trade always outweigh any short-term adverse effects; and innovation is distinct from production so that innovation capacity remains even if the production is distributed worldwide. Unfortunately, none of these arguments is correct.

DIEGO RIVERA, South wall, *Detroit Industry* murals, 1932–33.

Lost decade in manufacturing

The US manufacturing sector had a devastating decade between 2000 and 2010, from which it has only partially recovered. The decline is illustrated by four measures: employment, investment, output, and productivity assumptions.

Employment: Over the past 50 years manufacturing's share of gross domestic product (GDP) shrank from 27% to 12%. For most of this period (1965-2000), manufacturing employment remained constant at 17 million; in the decade from 2000 to 2010 it fell precipitously by almost one-third, to under 12 million, recovering by 2015 to only 12.3 million. All manufacturing sectors saw job losses between 2000 and 2010, with sectors most prone to globalization, led by textiles and furniture, suffering massive job losses.

Investment: Manufacturing fixed capital investment—plant, equipment, and information technology (IT)—actually declined 1.8% in the 2000s when adjusted for cost. This marked the first decade this has occurred since data collection began in 1947. It declined in 15 of 19 industrial sectors.

Output: US manufacturing output grew only 0.5% per year between 2000 and 2007, and during the Great Recession of 2007 to 2009, it fell by a dramatic 10.3%. Even as GDP began to slowly grow again (in what has been the slowest economic recovery in total GDP in 60 years), manufacturing output remained flat.

Productivity: Recent analysis shows that although the productivity growth rate in manufacturing averaged 4.1% per year between 1989-2000 while the sector was absorbing the gains of the IT revolution, it fell to only 1.7% per year between 2007 and 2014. Because productivity and output are tied together, the decline and stagnation in output mentioned previously is a major cause of the decline in produc-

The United States has simply not applied its innovation system to what turns out to be a crucial innovation stage, production, particularly initial production of complex, high-value technologies.

tivity in that period. Compared with 19 other leading manufacturing nations, the United States was 10th in productivity growth and 17th in net output growth. So productivity increases are not the significant cause of the decline in manufacturing employment. Political economist Suzanne Berger has noted that economists thought manufacturing was like agriculture, where relentless productivity gains allowed an ever smaller workforce to achieve ever greater output. She found the agriculture analogy was simply incorrect. This conclusion means that it is necessary to look at an overall decline in the sector itself for reasons why manufacturing lost nearly one-third of its workforce in a decade.

Part of the story of manufacturing's decline can be found in the nation's performance in the global market. Success in a highly competitive world rewards nations and regions that produce complex, value-added goods and sell them in international trade. Although world trade in services is growing, world trade in goods is four times trade in services. Complex, high-value goods such as energy, communication, and medical technologies make up over 80% of US exports and a significant majority of imports. The currency of world trade is in such high-value goods and will remain so indefinitely. Yet, the United States in 2015 ran a trade deficit of $832 billion in manufactured goods. That total included a $92 billion deficit in advanced technology products, a deficit that has been growing since 2002. The theory that the United States could keep moving up a production food chain, it could lose commodity production and keep leading production of advanced technology goods, is undermined by these data. Gradual growth in the services trade surplus ($227 billion in 2015) is dwarfed by the size and continuing growth of the deficit in goods; the former will not offset the latter anytime in the foreseeable future. A services economy does not allow the United States to dispense with a production economy.

Why is the country faring so poorly in high-tech trade? Part of the story is that US policymakers, under the influence of standard macroeconomic theory, were largely content to allow US manufacturing capacity to erode and shift offshore because they were confident that the knowledge and service economy would readily replace lost jobs and salaries from lost manufacturing. But it hasn't worked.

Recent decades have seen extended periods (1982-1987; 1998-2004; 2014-2016) where the dollar had high value against leading foreign currencies, with Treasury secretaries and Federal Reserve chairs generally supportive of a strong dollar. US manufactured goods correspondingly became less competitive in foreign markets. In parallel, from 1981 on, US consumption as a share of GDP began rising, reaching 69% in 2011, higher than the level in other developed economies. The strong dollar also helped push the country toward what many consider over-consumption compared to saving and investment; there was a growing production/consumption imbalance. The combination of an open trading regime, generally strong dollar, high consumption rates, and open financial markets created advantages for competitor nations' exports.

The China challenge

The trade imbalance between China and the United States substantiates this economic policy point: the United States has had deficit-ridden, effectively

import-oriented economic policies whereas China has been able to force savings rates and investment up to record levels and subsidize and grow exports. This contrast exposes as a dangerous myth the idea that advanced economies are subject to an inherent and inevitable decline of the manufacturing sector and manufacturing employment. Germany's continuing strong manufacturing sector is the obvious counter example. Its manufacturing workers are much more highly paid than their US equivalents, it employs 20% of its workforce in manufacturing, and it runs a major manufacturing trade surplus, including with China. A high-cost, high-wage production sector does not have to lose out to a low-cost one.

Meanwhile, China, after a three-decade effort, is now the largest manufacturing economy in the world. What led to this rapid shift in a field that the United States dominated for a century? Part of the story is the macroeconomic one told previously. Part of the story is China's neo-mercantilist policies to mandate technology shifts and to dominate markets with below-cost goods. Intellectual property theft has also played a role, and recent fiscal and market policies show how the West has underestimated China's nationalistic government economic controls. A seriously underappreciated factor has been Chinese innovation. Most experts have assumed China's rise is predominately due to low production costs from cheap labor and cheap parts. There is also an assumption in the United States that manufacturing must naturally migrate to low-cost producers and that the knowledge required for production processes is relatively trivial and readily replicable. Neither is true. As Jonas Nahm and Edward Steinfeld argue, China has undertaken a new link between process innovation and manufacturing by specializing in rapid scale-up and cost reduction. It has joined together skills in the simultaneous management of tempo, production volume, and cost, which enables production to scale up quickly and with major reductions in unit cost. This capability has allowed China to expand even in industries that are highly automated or not on governmental priority and support lists. The key to this ability to innovate new production processes has been the capacity of Chinese firms to accumulate firm-specific expertise in manufacturing through extensive, multi-directional inter-firm learning, taking advantage of international know-how from multinational corporations with manufacturing facilities in China, and building on it.

Economists long held that free trade gains always offset losses as trading partners played to their comparative advantage. Economists David Autor, David Dorn, and Gordon Hanson find that the trade relationship between the United States and China came with a heavy cost to US workers and their communities. They conclude that adverse consequences of trade are enduring. Traditional economic assumptions about the ultimate gains of trade are contradicted by the reality that the United States hasn't yet been able to get past the shock of the loss of millions of jobs in so many communities.

Autor and colleagues examined the direct impact of Chinese industry on incomes in some 700 US urban areas, comparing workers in heavily impacted areas (at the 75th percentile of exposure to Chinese competition) with workers in less-affected areas (at the 25th percentile). They found that income loss per adult was $549 greater in the most-impacted areas and that federal assistance in those areas increased income by only $58 per capita. The growth of trade with China, they find, has tended to make lower-skilled workers worse off on a sustained basis. There was no "frictionless" economic adjustment to other industries. Little offsetting growth was found in industries not affected by this "China shock." Instead, workers did not make up lost wages and their communities entered a slow, continuing decline.

As economics Nobelist A. Michael Spence has noted, "Globalization hurts some subgroups within some countries, including the advanced economies … The result is growing disparities in income and employment across the US economy, with highly educated workers enjoying more opportunities and workers with less education facing declining employment prospects and stagnant incomes." Just as manufacturing employment was a key to enabling less-educated workers to enter the middle class after World War II, the loss of manufacturing jobs is correspondingly a key element in the decline in real income for a significant part of the American middle class in the past few decades. Obviously, the 2008-09

Great Recession, where manufacturing (along with construction) was the leading victim, played a role, but there appears no getting around the trade effects, which have been longer term.

The weakening innovation system

But macroeconomic and trade factors alone don't provide an adequate explanation; the US innovation system is also implicated in today's socioeconomic climate. In the face of growing competition, the United States still retains the world's strongest early-stage innovation system—from university research through a culture that favors entrepreneurial risk-taking. Any manufacturing strategy must seek leverage from this comparative innovation advantage. However, federal research in the past has had only a very limited focus on the advanced technologies and processes needed for production leadership. This is in sharp contrast to the approach taken by Germany, Japan, Korea, Taiwan, and now China, which have a strong focus on "manufacturing-led" innovation. The United States has simply not focused research investments, education, or incentives on what turns out to be a crucial innovation stage—production, particularly initial production of complex, high-value technologies. This stage involves creative engineering and design, and often entails rethinking the underlying science and invention as it moves from proof-of-concept to the production stage. Innovation is not just research and development (R&D). Production innovation is an integral part of the innovation process, not an afterthought. Lack of attention to production innovation in the United States created a major gap in its innovation system.

This gap is especially acute for the 250,000 small and mid-sized firms, which represent 86% of US manufacturing establishments, employ more than half of its manufacturing workforce, and produce close to half of non-farm GDP. These smaller firms tend to lack the capacity to keep up with production innovation. They have been at the heart of the nation's economy, but they largely lie outside the innovation system.

Weakness in innovation for production is compounded by changes in the links between early-stage innovation and the production process. Since World War II, the US economy has been organized around leading the world in technology advances. It developed a comparative advantage over other nations in innovation, and as a result, it led all but one of the significant innovation waves of the twentieth century—in aviation, electronics, space, computing, the Internet, and biotech, having to play catch-up to Japan only on quality manufacturing. Its operating assumption was that it would innovate and translate those innovations into products. By *innovating here/producing here*, it would realize the full spectrum of economic gains from innovation at all the stages, from R&D, to demonstration and testbeds, to initial market creation, to production at scale, and to the follow-on life cycle of the product. This full spectrum worked, and the United States became

DIEGO RIVERA, West wall, *Detroit Industry* murals, 1932–33.

the world's richest economy.

Well, it worked in a world with limited global competition. But in recent years, with the advent of a global economy, the *innovate here/produce here* model no longer holds. In some industrial sectors, firms can now sever R&D and design from production. The development of computer-driven manufacturing systems had made it easier to distribute manufacturing to other locations across the globe. Today, firms using the distributed model

DIEGO RIVERA, West wall (detail), *Detroit Industry* murals, 1932–33.

DIEGO RIVERA, North wall (detail), *Detroit Industry* murals, 1932–33.

can *innovate here/produce there*. It appears this distributed model works well for many IT products, as well as for commodity products. Apple is the standard-bearer for this model, continuing to lead in dramatic IT innovations but distributing virtually all its production to Asia. But this approach has an inherent problem: since production is part of the innovation system, distributed production may lead to a shift in innovation capability offshore, cutting the US comparative advantage in innovation. *Produce there* may lead over time to *innovate there*.

Manufacturing still matters—a lot

Manufacturing is approximately 12.1% of US GDP, contributing $2.09 trillion to the nation's $17.3-trillion economy and employing 12.3 million people in a total employed workforce of some 150 million.

DIEGO RIVERA, North wall, *Detroit Industry* murals, 1932–33.

Manufacturing workers are paid 20% more than service sector workers. Growth economists tell us that 60% or more of historic US economic growth comes from technological and related innovation. And as the dominant implementation stage for innovation, manufacturing is a critical element in the innovation system, although the United States hasn't understood it this way. Industrial firms employ 64% of US scientists and engineers, and this sector performs 70% of industrial R&D. Thus US manufacturing strength and the strength of the nation's innovation system are directly linked.

Despite the decline in the manufacturing employment base, manufacturing remains a major workforce employment source for the economy, measured largely by workers at the production stage. But the official data is collected at the establishment level, not firm levels. Should the view of manufacturing be limited to the production moment? Why is the economic reach of manufacturing measured at the factory? This narrow lens provides only a partial perspective on the role of this sector.

The manufacturing sector, instead, can be viewed as an hourglass. At the center, the narrow point of the hourglass, is the production moment. But pouring into the production moment is the output of a much larger employment base, which includes those working in natural resource extraction, those employed by a wide range of suppliers and component makers, and the innovation workforce comprising the very large percentage of scientists and engineers employed by industrial firms. Flowing out of the production moment is another host of jobs, those working in the distribution system, retail and sales, and on the life cycle of the product. The employment base at the top and bottom of the hourglass is far bigger than the production moment itself.

Arranged throughout the hourglass are lengthy and complex value chains of firms involved in the production of the goods—from resources to suppliers of components to innovation, through production, to distribution, retail, and life cycle. This great array of skills and firms are now largely counted

as services, but in fact they are tied to manufacturing. If this production element is removed, the value chains of connected companies are snapped and face significant disruption. Although the lower base of the hourglass, the output end, may be partially restored if a foreign good is substituted for a domestic good, the particular firms involved will be disrupted. The upper part of the hourglass, the input end, with its firms and their employees, is not restored.

When these complex value chains are disrupted, it is very difficult to put them back together. A new Manufacturers Alliance for Productivity and Innovation study says the manufactured-goods value chain plus manufacturing for other industries' supply chains accounts for about one-third of GDP and employment in the United States. For every dollar of added value from domestic manufacturing (in technical terms, value-added destined for manufactured goods for final demand), another $3.60 of value is added elsewhere in the economy. For each full-time equivalent job in manufacturing dedicated to producing value for final demand, there are 3.4 full-time equivalent jobs created in nonmanufacturing industries, far higher than in any other sector. Higher-value-added production industries appear to have even higher multipliers.

These factors make it clear why, historically, once the value chains snap and the United States loses an economic sector, it's so hard to reassemble. Understanding manufacturing in terms of the hourglass and the value chains within it may provide part of the explanation for the economy's current predicament over job loss, job creation, and declining middle class median income. If one-third of our economy is being sacrificed to problematic economic views, it is no wonder that Trump is ascendant.

Manufacturing and democracy

New work by Autor and coauthors tends to bear out the relationship of disruption in the manufacturing sector to disruption in the political process. Analyzing congressional elections between 2002 and 2010, they found that increased exposure of local labor markets to foreign competition, particularly from China, tended to push both political parties toward candidates at their ideological extremes, polarizing the political process. The Trump candidacy is an extension of this development.

Trump voters identified at the outset of this essay have now completely disrupted one of the nation's two major political parties. There may be potential long-term consequences for the political system, which is indeed being pushed to its ideological edges. These voters appear stuck in their declining industrial communities strewn across the Midwest, the Northeast, and parts of the industrial South. Where could they move? To produce software in Silicon Valley? Biotech in Boston? As a number of economists are now grasping, these economically injured cities and towns can fall into failure mode. But their citizens have latched onto a new voice, Trump's, a profoundly disturbing voice to many. This voice is as disruptive as a month of massive protests on the Capitol Mall; its confrontational messages dominate night after night of evening news. US manufacturing workers were the historic base of Roosevelt's Democratic Party, they backed President Kennedy, began to shift parties in the Reagan era, and now that their prospects have significantly been eroded, they have blown up the Republican Party—the party of Main Street and Wall Street, of Lincoln and Taft, of country club and corner store, even of Rand Paul and the Kochs. It is now clear this disenfranchised group is so sizable that neither party can afford to ignore it. The parties must find a way to address grievances that have been long ignored as if this community was invisible. Both parties have embraced or tolerated a series of economic views and policies that fail to take into account the plight of these people. Will the political system be flexible enough to accommodate these recent outcasts without forfeiting democratic ideals? What would such a policy accommodation look like?

The Obama administration promised in 2012 to deliver 1 million new manufacturing jobs by 2016; only a third have materialized. But the president made manufacturing innovation the centerpiece of the technology agenda, hoping to have 15 advanced manufacturing institutes in place by the administration's end. These are organized around advanced production technologies, promising dramatic

efficiencies that can help offset higher US wage levels and restore manufacturing competitiveness. They aim to reconnect the innovation system to the production system, trying to rebuild a manufacturing ecosystem to better link small and large production firms and university engineering and science. It is a promising start, but more is required. The R&D system could do much more to focus on new manufacturing technologies and processes. Startups that could manufacture high-value goods are still shifting to contract manufacturers in places such as Shenzhen. Could there be new technology and know-how-rich spaces in the United States where startups could test and launch pilot production projects? The administration has been trying hard to increase college graduation rates, grow community college attendance, and improve workforce training. More is needed, including new online and blended learning systems that can radically expand access. New thinking on macro fiscal, tax, and trade policies and adjustments, and on longstanding economic assumptions, is still required. Trade-affected community assistance and job retraining must be rethought. The current political denouement tells us more will be needed from the next administration.

The nation can continue to ignore the manufacturing sector and let it erode still further, but the consequences for the innovation system and therefore to economic growth are significant. It now appears that there are also consequences for democracy and the nation's social ideals. If the nation's political leaders continue to write this neglected working class community off, the turmoil of this year's presidential primaries might be just the beginning of a period of social and political disruption. A strong manufacturing sector is a crucial element of an inclusive economy that can undergird a better future. Whoever voters send to the White House this November needs to recognize this reality and address it with energy.

Recommended reading

David Autor, "Skills, education, and rise of earnings inequality among the 99 percent," *Science* 344, no. 6186 (2014): 843-850.

David Autor, David Dorn, and Gordon Hanson, "The China Shock: Learning from Labor Market Adjustment to Large Changes in Trade," National Bureau of Economic Research Working Paper No. 21906 (2016a), doi: 10.3386/w21906.

David Autor, David Dorn, Gordon Hanson, and Kaveh Majlesi, "Importing Political Polarization? The Electoral Consequences of Rising Trade Exposure," MIT Working Paper (2016b), available online: http://economics.mit.edu/files/11499.

Suzanne Berger and the MIT Task Force on Production in the Innovation Economy, *Making in America* (Cambridge, MA: MIT Press, 2015).

William B. Bonvillian and Charles Weiss, *Technological Innovation in Legacy Sectors* (New York, NY: Oxford University Press, 2016).

Claudia Goldin and Lawrence F. Katz, *The Race Between Education and Technology* (Cambridge, MA: Harvard University Press, 2008).

Adams B. Nager and Robert Atkinson, "The Myth of America's Manufacturing Renaissance: the Real State of US Manufacturing," Washington, DC: Information Technology and Innovation Foundation (2015).

Melissa S. Kearney, Brad Hershbein, and Elisa Jacome, "Profiles of Change: Employment, Earnings and Occupations from 1990-2013," Washington, DC: The Brookings Institute (2015).

Dan Meckstroth, "The Manufacturing Value Chain is Bigger than You Think," Washington, DC: Manufacturers Alliance for Production and Innovation Foundation (2016).

Jonas Nahm and Edward S. Steinfeld, "Scale-Up Nation: China's Specialization in Innovative Manufacturing," *World Development*, 54, no. 288 (2013).

Derek Thompson, "Who are Donald Trump's Supporters, Really?" *The Atlantic* (2016).

William B. Bonvillian directs MIT's Washington office and teaches courses on innovation policy at MIT, Georgetown, and Johns Hopkins universities. He was an advisor to MIT's "Production in the Innovation Economy" study of 2013–14, and worked on the President's Advanced Manufacturing Partnership reports. This article draws from his recent book with Charles Weiss, Technological Innovation in Legacy Sectors *(2015).*