



THE STATE OF

MANUFACTURING

by Andy Henderson



2016 REVIEW + 2017 OUTLOOK



EXECUTIVE SUMMARY

The heavy/discrete manufacturing industry is poised, thanks to both shifting models and new technologies, on the edge of an innovative new period that promises significantly greater productivity and potentially lower costs.

The industry is looking at the supply chain in a different light; digital tools will add efficiencies, limit a manufacturer’s vulnerability to outside influences or production schedules, and simplify regulatory compliance.

Meanwhile, smart sensors and automation technologies promise to make the factory of the future more efficient and safer for human operators and employees than ever before. Recognizing the importance of continued innovation in the areas of smart sensors and automation, the private sector, academia, and governments—sometimes independently, and increasingly in partnership with one another—are investing heavily in research and development as well as implementation strategies to make both vertical industries and national manufacturing sectors better able to compete in 21st century manufacturing. These efforts will transform how we see and experience the factory going forward.

Amid all this change and modernization, however, an unexpected turn of events within the global geopolitical landscape may also have a lasting effect on heavy/discrete manufacturing. An international and particularly intense backlash against globalization, or its perceived effects, rocked the political landscape on both sides of the Atlantic. The concept of globalization may be in something of a retreat, or at least a redefinition. As this occurs, international heavy manufacturers could well find themselves redesigning their in-market models, which would obviously have a compelling impact on what the industry looks like in the next decade and beyond.

As heavy manufacturing enters the next decade, what we know with certainty is that the industry will be different in just a few years than it is now.



Smart sensors and automation technologies promise to make the factory of the future more efficient and safer for human operators and employees than ever before.



2016

MAJOR EVENTS IN THE HEAVY/DISCRETE MANUFACTURING INDUSTRY

May/November Obama Administration creates an overtime rule that would raise the wage thresholds for required overtime pay. However, a preliminary injunction halted the implementation of the rule in November.

DMDII announced that it will invest \$12M into augmented reality and wearable tech projects

May 10

May 18

UPS announces the launch of an On-Demand 3D Printing Manufacturing Network

June 20

July 20

President Obama announces winner of new Smart Manufacturing Innovation Institute

Elon Musk reveals the Tesla Master Plan, Part Deux

Nov. 8

U.S. presidential election; Donald Trump's Electoral College win foreshadows possible shifts in U.S. trade policy for 2017 and beyond

July 20

Brexit: The UK votes to leave the E.U.

China announces intention to build 40 manufacturing innovation centers by 2025

Aug. 30

Feb. 5

India Prime Minister Narendra Modi pledges to increase "Made in India" efforts

Dec. 31

China ends the year with [fifth straight month of growth](#) in its manufacturing sector, although this growth is considered suspect by some economists



2016

IN REVIEW



Technological advances and new ways of thinking about the manufacturing process and supply chain looked, at the beginning of the year, to be the themes that would set the predominant tone for 2016. And to be sure, these themes were significant players in the year's developments. But 2016 also featured a wild card: the increasing backlash against globalism that prominently impacted the politics of several leading Western manufacturing nations, and caused a good deal of uncertainty and speculation about the possible economic impact.

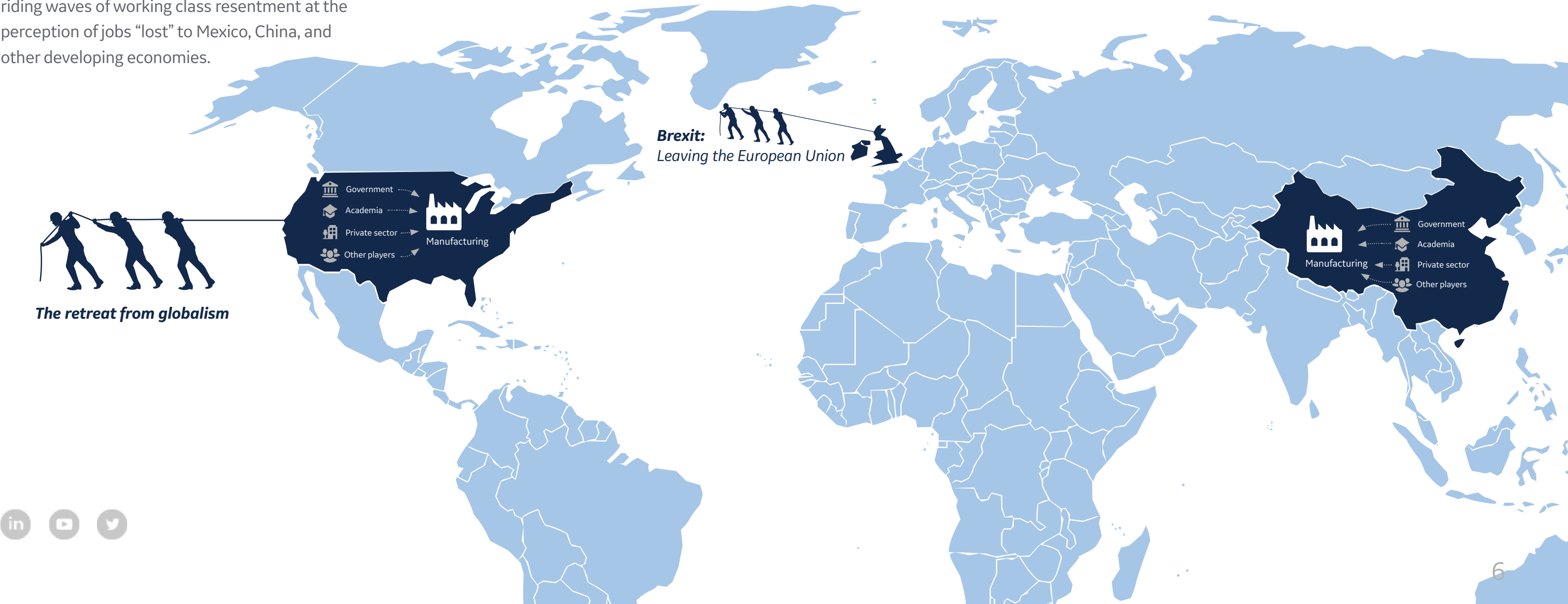
In July, a majority of voters in the United Kingdom voted in a referendum to leave the European Union.

The vote, nicknamed “Brexit,” was influenced by many factors—but among them was a concern (especially among working class Britons) that integration with the E.U., and globalization in general, has come at the cost of British jobs, especially in manufacturing. In November in the United States, Donald Trump scored an upset victory in the U.S. presidential election, in part by riding waves of working class resentment at the perception of jobs “lost” to Mexico, China, and other developing economies.

These and other, similar protectionist developments and tides of opinion in other major economies led some major executives—including [General Electric’s Jeff Immelt](#) prominently among them—to consider different approaches to doing international business, focusing a bit more on localization of efforts and potentially looking at reduced exports. This emphasis on localization might have been coming anyway, but the wave of anti-globalization has led leaders to consider strategies on something of a different timeline.

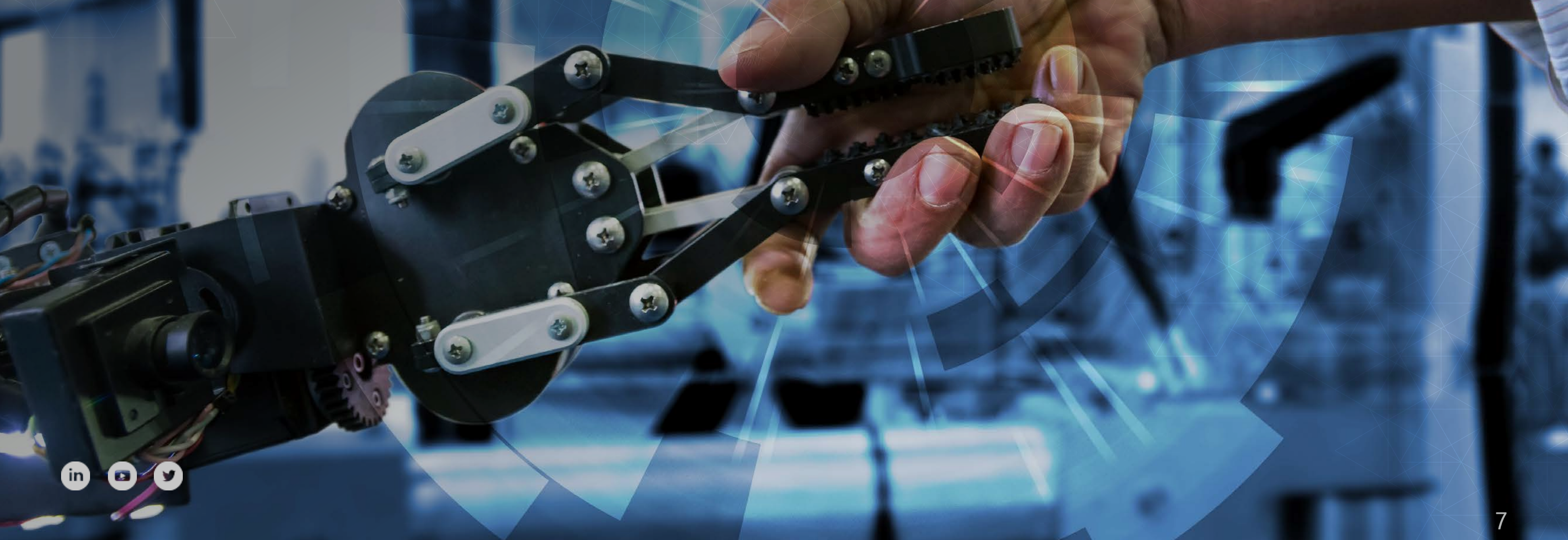
But even though the rise and influence of anti-globalism significantly influenced manufacturing in 2016, the predominant and most far-reaching theme of the year remained the concerted and focused efforts to move manufacturing to its smarter, more efficient, more innovative future.

Through the “Manufacturing USA” and “Made In China” initiatives, respectively, the American and Chinese governments got more deeply involved in stimulating investment—either directly by the government, or partnering to encourage it from the private sector—in technologies that will move the heavy/discrete manufacturing industries forward and improve their competitiveness in today’s environment.



WHAT'S AHEAD IN

2017



Manufacturing innovation

The heavy manufacturing industry continues to experience moves to accelerate innovation.

These moves are driven, in some cases, by new developments in the manufacturing process, and in others by the emergence of new products and technologies designed to make heavy industrial manufacturing more efficient, more competitive, and more supportive of modern industrial needs. Across the board, from the private sector to academia to even governments, we are seeing aggressive investments to futurize manufacturing. Sometimes these investments were made independently, although several significant efforts involved partnerships between all of these sectors.

Factory of the future

Tesla's "Gigafactory," currently under construction in the desert outside of Sparks, Nevada may represent not just what future factories look like, but how companies approach their entire manufacturing process. Not just a facility with higher levels of advanced automation than previously seen, the Gigafactory also represents an initiative by Tesla—one that will very likely be followed by other heavy manufacturers—to consolidate and control its entire supply chain.

Tesla founder Elon Musk has talked extensively about turning the factory into a product—"the machine that builds the machine"—and has made some lofty claims about a 5-10X improvement in automotive manufacturing based on first-principles analysis. Time will tell whether these productivity aspirations will bear out for Tesla's factory. But the concept of developing highly automated factories that are purposeful to the product being manufactured is fundamentally sound, and promises to dramatically impact efficiency while lowering costs. And regardless of predictions, the Gigafactory is underway—providing a real-world example of how this kind of factory will look.

Within the Gigafactory, Tesla will produce the batteries that power its vehicles—but by bringing everything involved in the process of building batteries into one facility. Bringing in raw materials like lithium

from nearby sources, the Gigafactory will handle every aspect of battery production—from producing individual cells to assembling thousands of these cells into the battery packs that power Tesla vehicles. Tesla suggests that consolidating production in this way could lower battery costs by up to 30%¹.

This consolidation, reminiscent of Henry Ford's River Rouge complex in Dearborn, MI, is one part of what Musk refers to as his "Master Plan, Part Deux," and is a practical application of the concept of a vertically integrated factory—one in which raw materials and components are developed in the same facility as the final product. This model could, if adopted by more heavy manufacturers, reduce supply chain costs and reduce reliance on external suppliers' R&D schedules, labor issues, and access to raw materials.

¹ <https://www.wired.com/2016/07/tesla-gigafactory-elon-musk/>

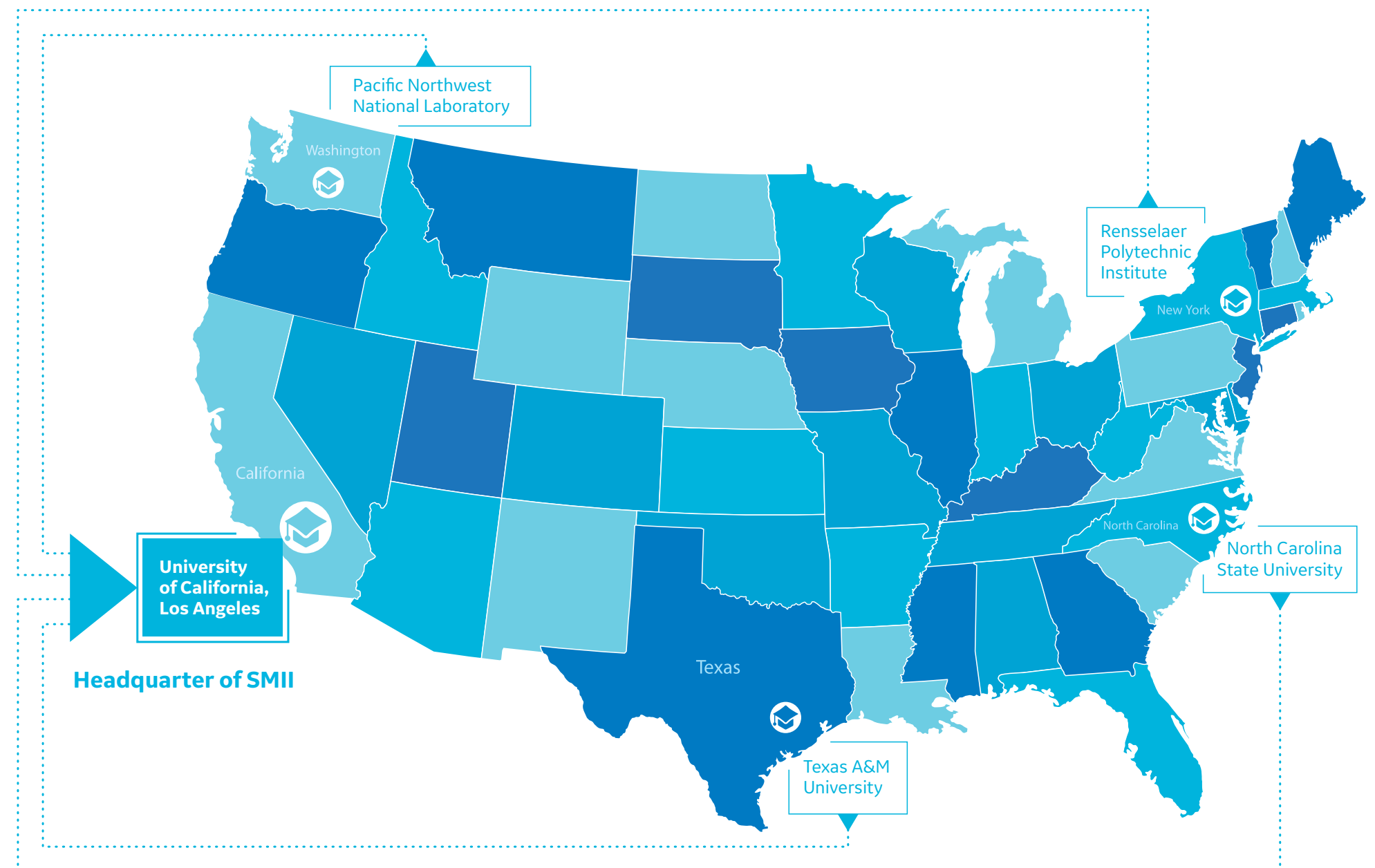
Many other industry leaders are also envisioning and working on factories of the future. GE has been investing internally to transform factories into “Brilliant Factories.” The government of South Korea is backing a “Smart Factory” initiative for Korean manufacturers. However, for all manufacturers, the message is clear: Success in 2017 and beyond will require us to consider far greater levels of smart automation within our production facilities, and will make it necessary to think about how we better integrate more or all of our supply chain into our production. The scope of these initiatives is daunting: robots, artificial intelligence, end-to-end security, scalability, flexibility, and robustness are required. Manufacturers should consider partners who have developed expertise in these areas and are willing to work with others to grow in the ecosystem.

Innovation partnerships

Recognizing the role smart sensors will play in the manufacturing facility of the future, the Smart Manufacturing Leadership Coalition announced in July its ninth Manufacturing USA center, the **Smart Manufacturing Innovation Institute (SMII)**. The SMII is an advanced manufacturing hub intended to drive advances in smart sensors and digital process controls that could dramatically, even exponentially, improve the efficiency of U.S. advanced manufacturing.

The coalition that will lead the new institute is comprised of nearly 200 academic, industry, and non-profit organizations, along with the Department of Energy—and brings \$140 million in public-private investment to develop these smart sensors for advanced manufacturing.

Headquartered in Los Angeles, SMII is made up of five manufacturing centers—one each at the University of California, Los Angeles, Texas A&M University, Rensselaer Polytechnic Institute, the Pacific Northwest National Laboratory, and North Carolina State University. Each center, while reporting in to the Los Angeles hub, emphasizes local technology transfer and workforce development.



The five manufacturing centers of SMII, emphasizing local technology transfer and workforce development, report to the LA headquarters.

The SMII, like all Manufacturing USA institutes, will host and facilitate advanced university research as well as corporate and government research and development. The SMII's specific focus on smart sensors and digital process controls is intended to jump-start advances in these areas to upgrade the efficiency of U.S. advanced manufacturing.

But the purpose and benefit aren't limited to just the discovery or invention of innovative new technologies. Rather, the Manufacturing USA institutes are intended to help bridge the gap from where initial speculative investment traditionally falls off to the point where new technologies enter the marketplace and begin to recoup those investments. In a sense, the Manufacturing USA institutes will function as much as an accelerator as a pure research effort—the goal is to facilitate the rapid infusion of these new technologies into U.S. manufacturing. At times this could be through direct acquisition; in other instances, it is possible that entirely new supplier SMBs (small or medium businesses) could productize the emerging technology.

The U.S. effort is similar to the work of the German government, which is investing more than €200 million euros across government, academia, and business in order to spur development and implementation of digital processes and technologies into manufacturing. Industrie 4.0, as the Germans have christened it, is a favorite subject of German Chancellor Angela Merkel, who makes frequent reference to its urgency and has encouraged, [in a speech at the World Economic Forum in Davos](#), all of Europe to embrace digitization, automation, and what some call the Industrial Internet of Things (IIoT). Merkel and other German leaders see the infusion of internet and digital technologies into manufacturing as critical to Europe's ability to continue to compete in heavy manufacturing in the next decade and beyond.



The Chinese government, too, seems to recognize this same urgency to sponsor and support the acceleration of advanced technologies into its manufacturing sector, seeing such effort as critical to their economic competitiveness in the coming years.

The Chinese Ministry of Industry and Information Technology (MIIT) has announced plans for a network of manufacturing innovation centers—a network that bears several similarities with the U.S.'s plans for Manufacturing USA—as part of a broader initiative by the Chinese government called “Made in China 2025.”

The Made In China 2025 initiative aims more broadly than just digitization. Another of its purposes is to instill more consistency in terms of quality and efficiency across all Chinese manufacturing. But a big part of achieving these goals is the same rapid development and implementation of technology that enables smart factories that Germany and the United States are emphasizing.



China finds itself in a uniquely challenging position. As its middle class continues to grow and wages begin to increase, it faces new pressure from lower manufacturing cost countries. At the same time, the more developed nations in the West recognize significant competitive advantage against the lower wages paid to workers in China through the faster and more efficient adoption of new technology, innovation, and advanced practices. Recognizing that they will not be able to compete on cost with lower cost neighbors in Asia or elsewhere in the future, the Chinese government sees their path to manufacturing growth in similarly accelerating the development and adoption of advanced technology, automation, smart sensors, and the intelligent factory. The Made in China 2025 network reflects the Chinese government’s ambition to compete in that area.

The takeaway from these efforts that heavy manufacturers should take to heart is this—leaders of the world's foremost manufacturing countries, with varying approaches to economic management, are all deploying significant and highly focused resources to address the need for digitization and the upgrade of their manufacturing sectors with smart, inter-connected technology—part of what is popularly called “digital transformation.” These governments are investing significant effort and resources to ensure that this innovation and advancement happens.

It is very important to note that digital transformation encompasses much more than smart, intelligent, interconnected manufacturing operations.

It also encompasses leveraging digital technology to transform every aspect of how a business operates—from sales and marketing to engineering design and manufacturing, out to customers and back again—as well as considering how a business might use digital technology to provide new services for their customers or establish new business models.

Any company not thinking along these lines, and not making the according investments in technology, R&D, and people to upgrade its own factories will quickly fall behind in the next few years. Within a decade may find it too difficult to successfully compete on either a regional or a global stage.

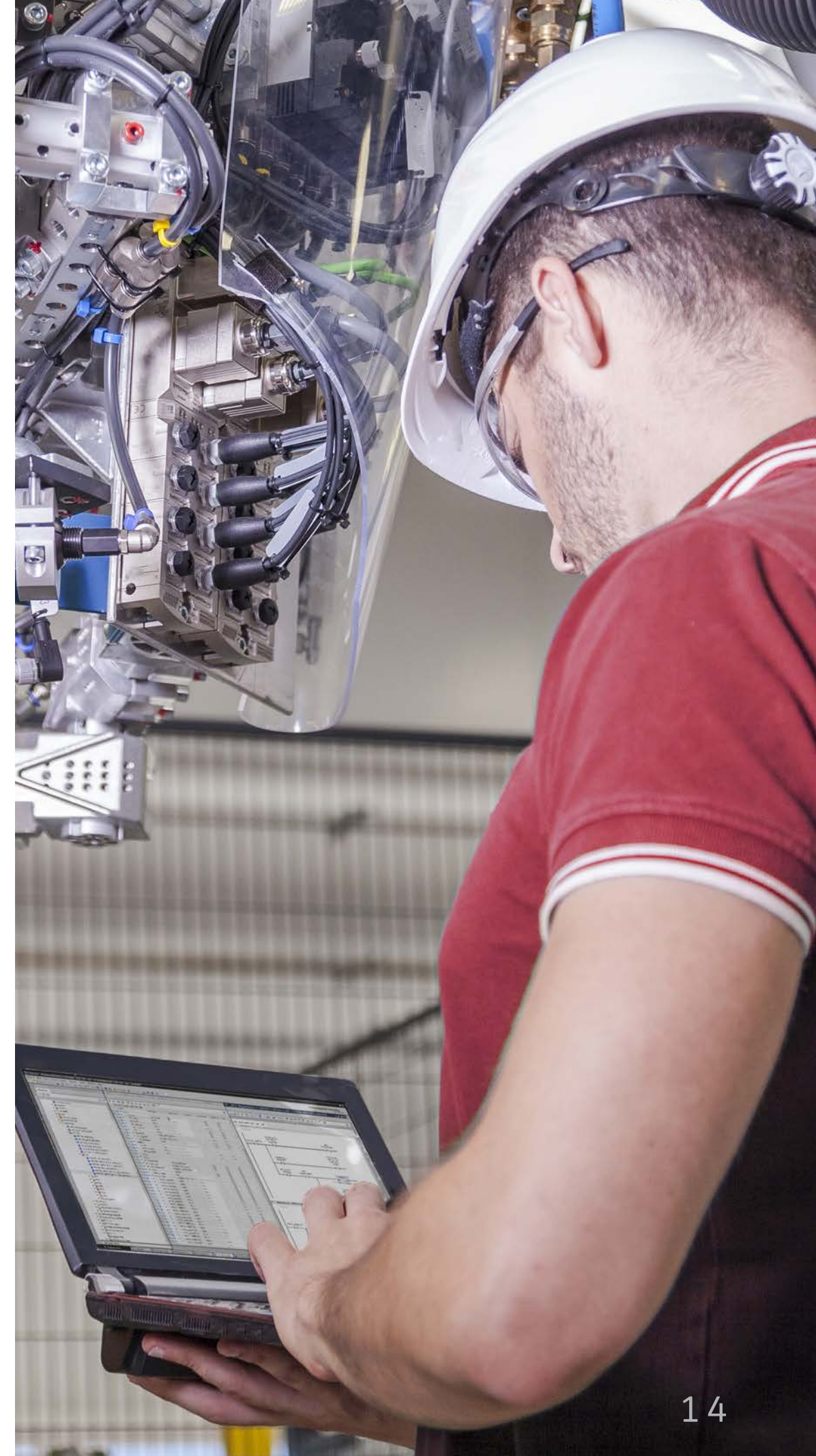
We are far enough along in the digital age that technology has already transformed the way every business operates, regardless of industry sector. Those changes represent perhaps only the tip of the iceberg. Moore's law is still holding true. Digital technology is still accelerating at blinding speed, and the changes coming

from artificial intelligence, autonomous production, and the Industrial Internet of Things (IIoT) promise to be even more disruptive and drive even more change than what have experienced in the past two decades. It is not alarmist to suggest that any business that does not adapt and adopt to this next generation of technology will become antiquated and be left behind—in fact, they may well not survive.

Not even a dominant market position in an industry inoculates a business from the effects of adapting and transforming too slowly. Consider the experiences of Kodak and Polaroid in the 21st century, as digital technology first displaced film and then displaced the camera itself (at least for the casual user). As we continue along the path to digital transformation, no company should think itself too big to be displaced or made obsolete; every leader must have a sense of urgency to push their organizations further down this path.

One example manufacturers might consider looking at to see how an established market-leading company is embracing the new frontier of digital technology is UPS. They are [embracing Additive Manufacturing](#) as a trend that could reshape all of logistics, and are offering new services to produce and sell parts to manufacturers.

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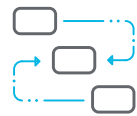


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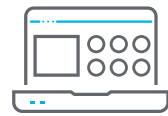


Transforming after-sale service delivery

Three trends impact heavy equipment manufacturers, creating a post-sales environment that demands attention and provides tremendous opportunity.



Customers demand service transparency and rapid response



Smart connected devices generate rich, instantaneous data for equipment installed on customer sites



The skilled labor gap is challenging service teams to find new efficiencies and improve first-visit fix rate

According to a 2017 Technology Services Industry Association report, 73% of field service providers report they have struggled to achieve profitable revenue growth.² Those that are most successful demonstrate a relentless focus on customer experience as essential differentiation.

Those manufacturers that strategically take action to transform after-sale service delivery will be the long-term industry winners by delighting customers while controlling costs.

² <http://info.tsia.com/the-state-of-field-services-2017>

Delight customers in times of extreme expectations

Today's equipment buyers operate in what we call the "Amazon era," where they have been trained to expect complete transparency, before and after a sale has been made. As such, equipment manufacturers must deliver remote diagnostics and preventative and proactive services, schedule on-site repairs rapidly, document easy-to-follow maintenance practices, and offer accurate resolution estimates.

Sensor data will enable true condition-based maintenance with pinpoint precision, resulting in an estimated 10–30% in maintenance cost reduction.

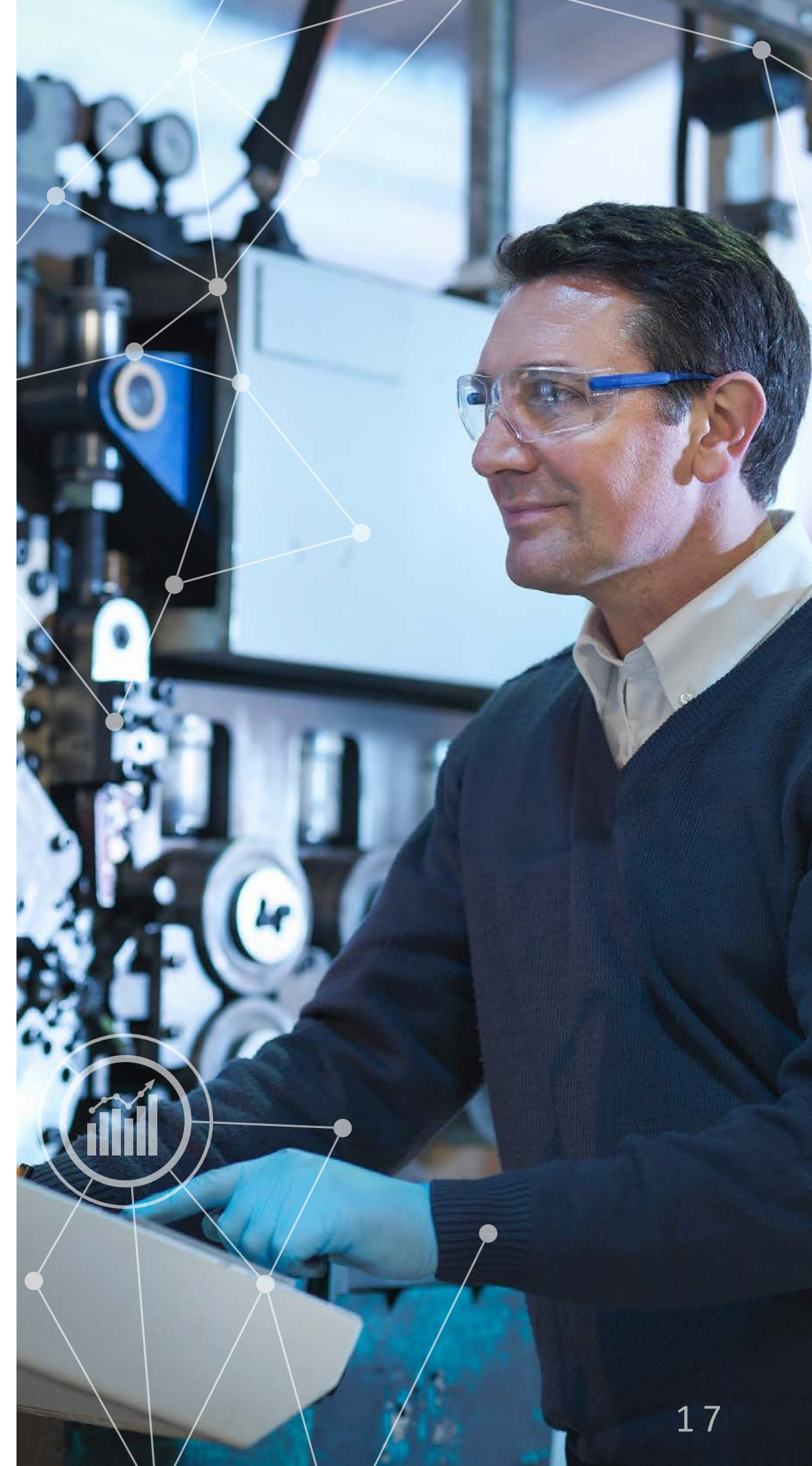
Creating new value with data insights

Sensor data will enable true condition-based maintenance with pinpoint precision, resulting in an estimated 10–30% in maintenance cost reduction.

Modern industrial equipment is heavily instrumented, giving a voice to mechanical or electronic components—measuring everything from inventory levels to temperature discrepancies. Centrally monitoring and taking action based on this information can have a direct impact on the cost-effectiveness of a service business.

- Service technicians no longer have to wait for a physical inspection or manually initiated data process to collect critical data.
- Since information collection happens as a background task, a wide range of data points can be sent without disrupting operations.
- Data collection happens automatically, eliminating human error, creating not only a comprehensive data set, but an incredibly accurate one.

Leading companies are using sophisticated cloud-based analytics to detect subtle variations in how equipment is operating and to use these signals as a predictive indicator of future issues and downtime—allowing the OEM to prevent potential issues.



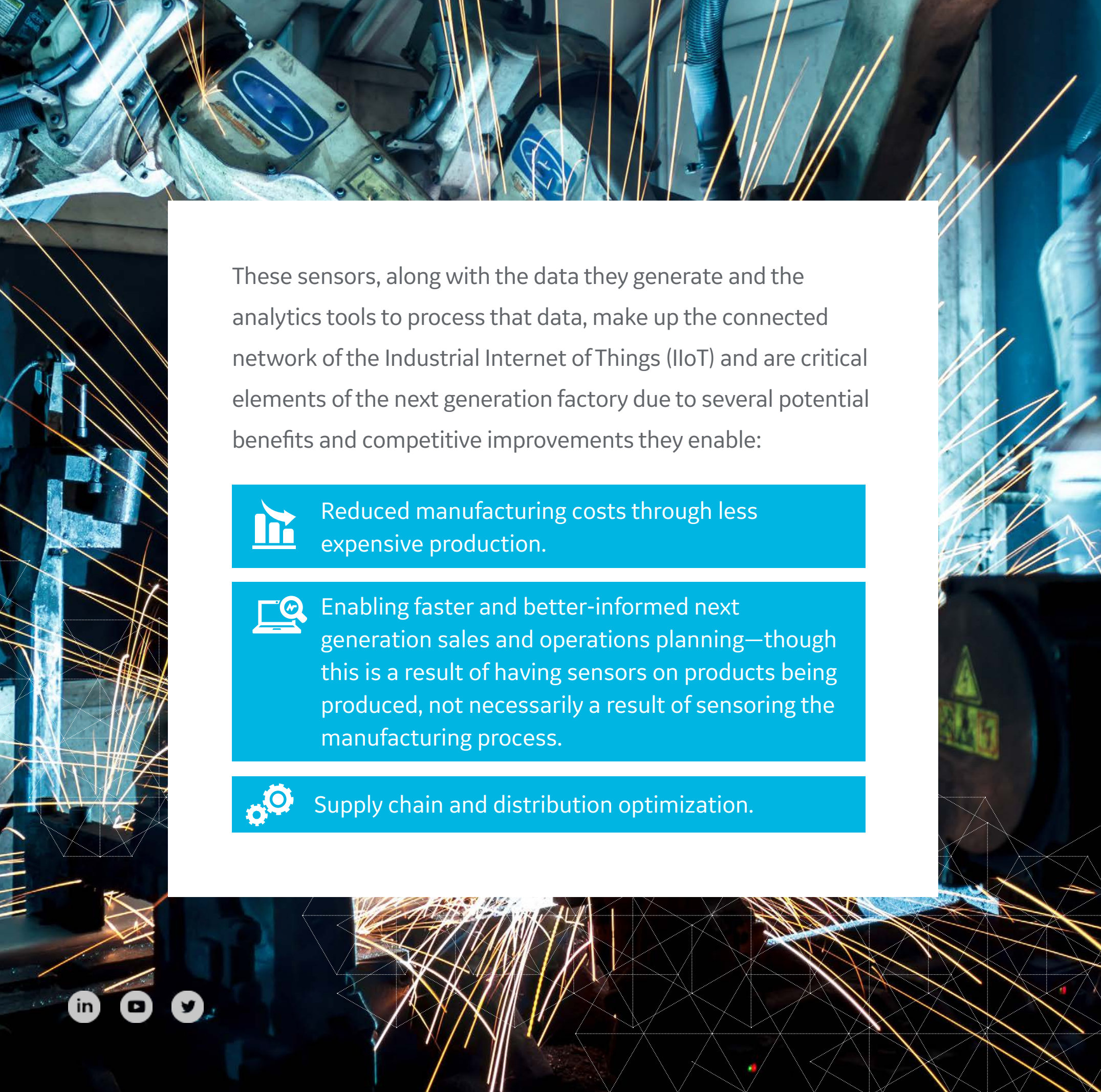
4.0 Cyber Physical Systems

Data-driven manufacturing

The focus on smart sensors and advanced automation technology is not incidental.

Data-driven manufacturing has been leveraged for more than a century to improve manufacturing operations. It has taken the form of Taylor's Scientific Management, Deming's Statistical Process Control, and Six Sigma. But data gathering has been, in many cases, a long and arduous task—and the analysis has been dependent on the skill and knowledge of the analyst.

Cheap and ubiquitous sensing has afforded an unprecedented ability to gather copious amounts of granular process data in real-time. An abundance of computing power has provided manufacturers the ability to analyze enormous swaths of data. With the proper algorithms and interfaces, the software will level the analysis field. All of this promises to provide manufacturers with an unprecedented ability to detect, avoid, and mitigate production issues while also providing insights into cost and time drivers.



These sensors, along with the data they generate and the analytics tools to process that data, make up the connected network of the Industrial Internet of Things (IIoT) and are critical elements of the next generation factory due to several potential benefits and competitive improvements they enable:



Reduced manufacturing costs through less expensive production.



Enabling faster and better-informed next generation sales and operations planning—though this is a result of having sensors on products being produced, not necessarily a result of sensing the manufacturing process.



Supply chain and distribution optimization.

OTHER VOICES

Smart sensors and the digital transformation of manufacturing

“Sensors are already in place throughout manufacturing operations, as is the ability for fairly secure broadband communication in the plant. What is needed is to utilize, in a secure fashion, the data that is being generated in the plants. Unless processing is done on the data very near its source in the plant, cloud storage and computing will be necessary to fully utilize the data, and such capabilities are now readily available at very low cost. So the big data transformation will accelerate in 2017.”

Dr. Thomas Kurfess

**HUSCO/Ramirez Distinguished
Chair in Fluid Power and Motion
Control Professor**

**George W. Woodruff School of
Mechanical Engineering**

Georgia Institute of Technology

“Without a doubt, digital transformation in manufacturing has become a major initiative the past few years, and it continued its acceleration in 2016. EMO in Milan in October 2015 left many attendees wide-eyed at all the buzz around IIoT. Then, a year later at IMTS 2016 last September, IIoT was presented in some form in every hall, in every booth. Because machine tools (CNC lathes and mills) have a hand in producing just about everything man-made, data from machine tools can tie into the very beginnings of the digital thread of all products. This has machine tool companies very interested in participating and supporting IIoT efforts.”

Jim Kosmala

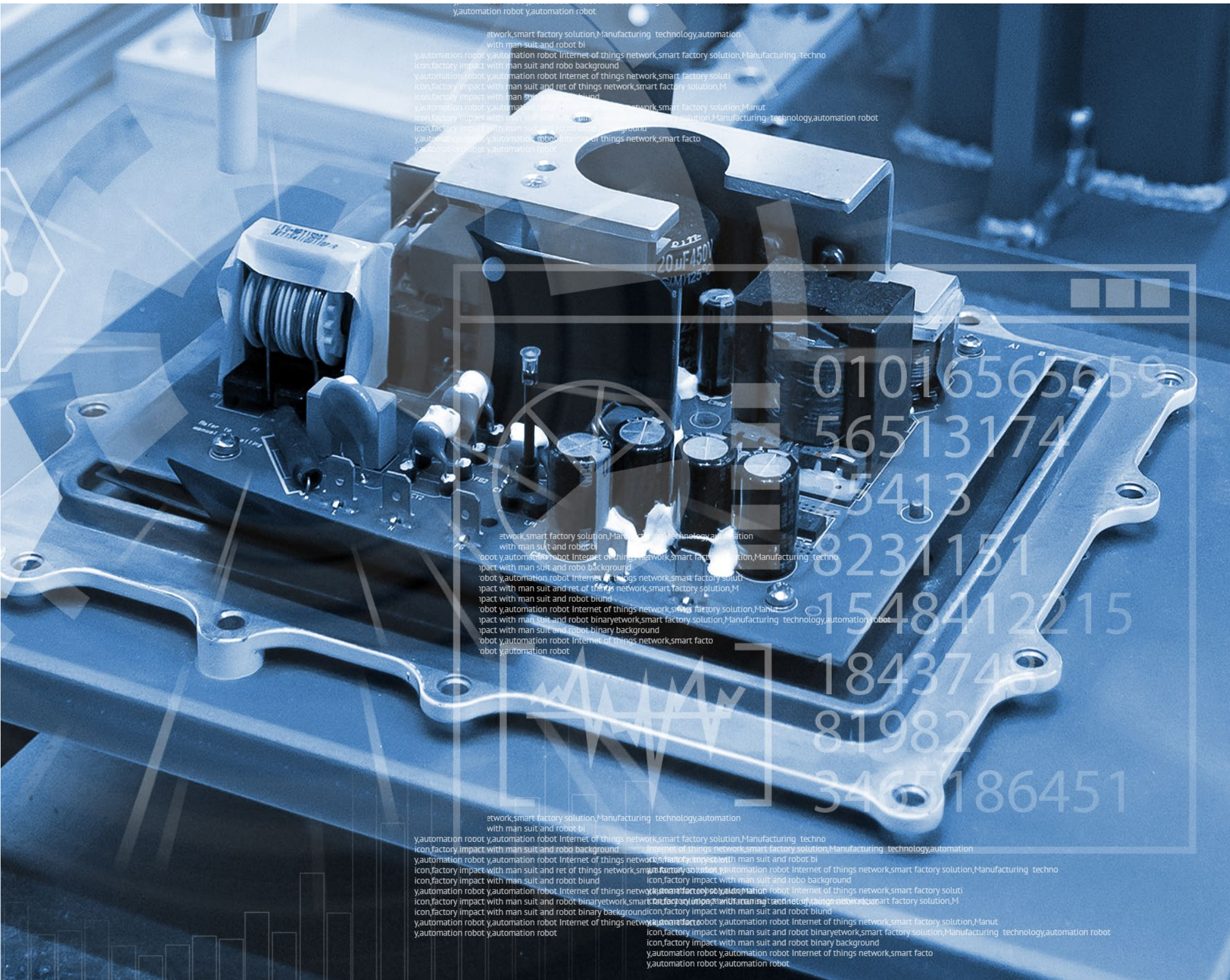
VP of Engineering, Okuma America



Making this digitized, smart factory work its magic is about more than just deploying sensors and collecting data. There are also operational changes and process updates that become paramount in a sensor-enabled, data-driven manufacturing facility.

Smart sensor-enabled facilities will generate data in real-time or very close to it—and the manufacturing (or production) ecosystem will respond in real-time to the information collected. Operations or processes will occur at such time that the system flags itself or its operators that they should occur. Everything from preventative maintenance, to more efficient configurations, to adjusting for fluctuations in demand will be triggered by data. This shift in operations requires process adjustments, investing in data security and backup, and importantly requires bringing in the right people with the right skills to manage these processes. Heavy manufacturers must understand the procedural and human shifts necessary to best leverage what an IIoT-based manufacturing model can offer them.

Everything from preventative maintenance, to more efficient configurations, to adjusting for fluctuations in demand will be triggered by data.



The changing manufacturing workforce

Over the past year or so, multiple narratives have played out in politics and media—each of which have some truth to them, and are often used as tools of persuasion depending on whose agenda is being pushed, and sometimes offered to counter another narrative:

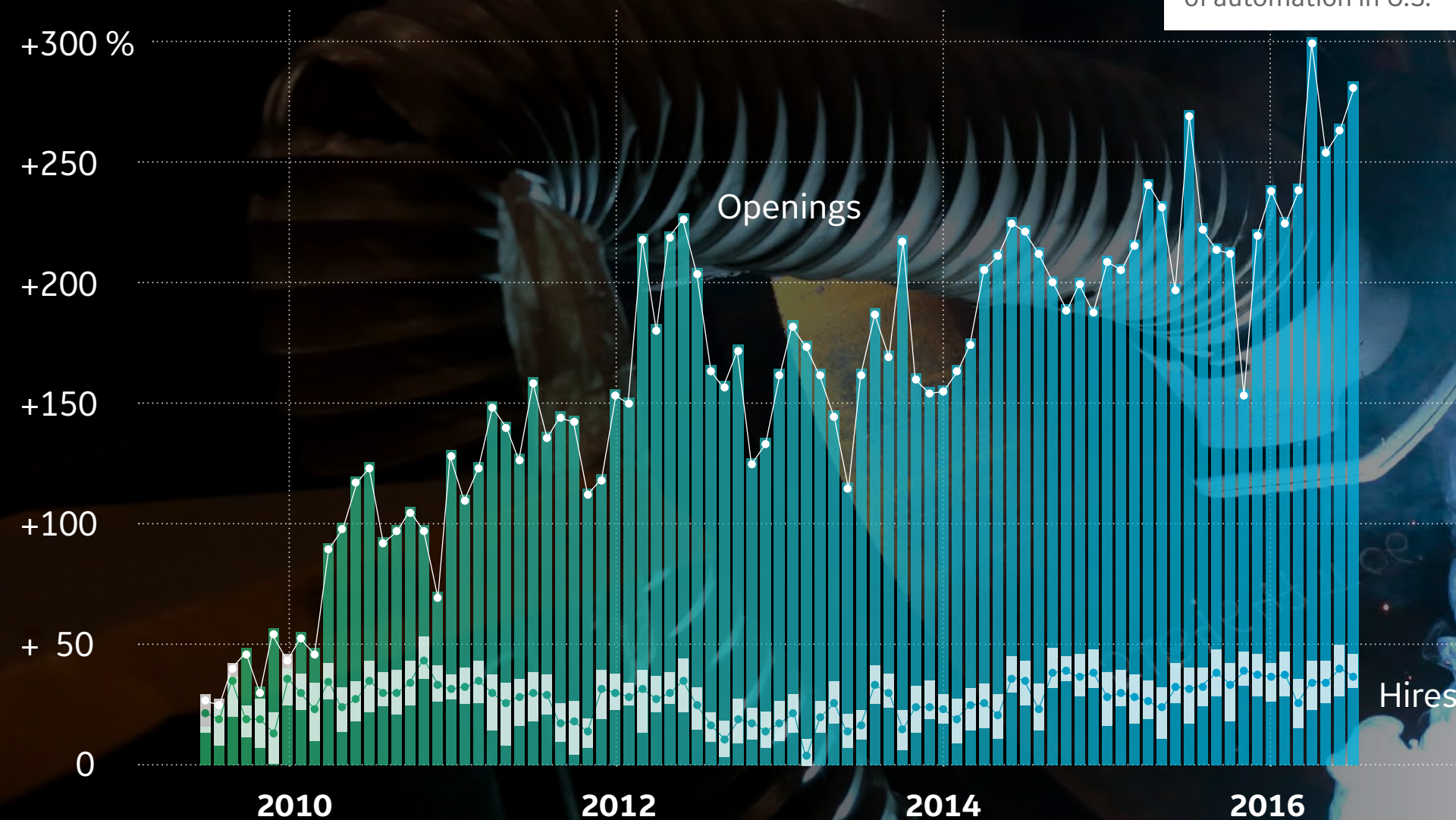
01 Certain locations and industries have experienced reductions in jobs due to offshoring.

02 **The counter-argument to point 1:** U.S. production has continued to increase in recent years but jobs have not increased; this, many believe, points to a higher level of automation in U.S.

03 There are actually a high number of manufacturing jobs currently posted in the U.S., but no skilled talent to fill them.

04 **The counter to point 3:** There is a lack of data to suggest widespread wage increases and talent poaching—making it somewhat questionable as to whether there is actually a skills gap.

Manufacturing job posting and hiring from 2009–2016³



To the first set of points, the media has lately been focused on the narrative of U.S. companies' reshoring. There was a strong focus from the current administration to re-shore manufacturing. However, many observers point to rising wages in China and more automation in U.S. facilities as equally or even more significant factors.



³ <https://fivethirtyeight.com/features/dont-blame-a-skills-gap-for-lack-of-hiring-in-manufacturing/>

Tackling the skills gap to contain post-sales service costs

Inefficient use of skilled resources drags profits down. More than 70% of manufacturers report at least a 5% increase in overtime costs, and nearly one-third report a greater than 10% increase in overtime costs as a result of not being able to fill skilled roles.⁴

Manufacturers are using two key strategies to mitigate disruption from the skills gap related to post-sales service appointments. First, equipment manufacturers must send the right resources, both people and parts, to get on-site repair right the first time. Second, the organization must strive to improve preventive maintenance practices, which cost as little as 1/10th as much as unplanned repairs.

Leveraging a digital twin to detect precursors of equipment failures is an essential tool to accomplish these strategies. Think of a digital twin as a computer model of the “perfect” piece of equipment. Comparing actual equipment state and health to the digital twin can highlight deviations from optimal performance. These anomalies can highlight potential issues weeks or months before they impact your customer.

⁴ <http://www.themanufacturinginstitute.org/Research/Skills-and-Training-Study/Skills-and-Training-Study.aspx>



To be sure, automation does change the mix of jobs, both in and around factories.

Much of the traditional repetitive or dangerous work is being automated—driving the need for new sets of skills, and specifically spurring a need for technicians and programmers. So while it may be accurate to state that automation is making some jobs obsolete, the reality is that automation does not always mean fewer jobs, it merely requires or enables different jobs. And that brings us to the second pair of positions: the changing skills needed in manufacturing.

When I've talked with people in factories, at conferences, and within GE, a common concern emerges. There are not enough skilled people to fill manufacturing jobs and keep up with demand. This is usually coupled with a discussion about the large number of baby boomers who are reaching retirement age. Many groups are looking at apprenticeship programs to train talent and give apprentices a direct path into the company. Manufacturers also must battle a generational culture that glorifies technology-related jobs and entrepreneurship—making it sometimes an uphill battle to get millennial workers interested in a manufacturing sector job or career.

But while it's not as sexy a story for the media as offshoring, reshoring, or automation, one of the primary jobs challenges facing U.S. manufacturing is that 21st century manufacturing requires new or different skills than it has in the past.

This challenge has generated initiatives in many states where high schools are reinstating manufacturing classes and emphasizing the skills needed in the “new” factory. Universities are also refocusing on advanced manufacturing curricula, and many companies are working more closely with technical colleges to develop two-year programs in advanced manufacturing.

These steps—reimagined curricula, renewed focus on training and preparation for manufacturing careers, the raising of awareness about the need for new manufacturing skills, and the availability of good, skilled manufacturing jobs—may help American manufacturers address their need for qualified job candidates. But, as some economists have pointed out, heavy manufacturers [may not be moving fast enough to help themselves address the job glut](#).

OTHER VOICES

The state of manufacturing jobs and the need to invest in better training for the next generation of manufacturing jobs

“It seems for the past decade or so, manufacturing has observed a decline in the availability of skilled labor. Combinations of reasons for this have been cited, such as the aging Baby-boomer generation, off-shoring, and the decline of American manufacturing in general transferring to low-cost labor markets.

Perhaps less anticipated has been the ability for manufacturing companies to attract and retain the new generation of millennials. There's been a lot of chatter about new leadership and management strategies that appeal to millennials in recent years, and 2016 validated the need for that, as manufacturers are beginning to see more and more the need to pay more attention to the generation differences.”

Jim Kosmala | VP of Engineering, Okuma America

21st century manufacturing requires new or different skills than it has in the past.



But the challenge does not end at the “working” level in a facility. As we move into the digital age, we also need to reconsider the skills of operations leadership.

Manufacturers have traditionally hired industrial and mechanical engineers to develop and oversee manufacturing processes. these disciplines are still critical—but they will need to be complemented with more electrical and controls engineers, data scientists, and programmers.

OTHER VOICE

The state of manufacturing jobs and the need to invest in better training for the next generation of manufacturing jobs

“It is clear that low-skilled manufacturing jobs are rapidly disappearing not only in the United States, but in all regions of the world. What this highlights is that there is an ever-growing need for skilled labor in the manufacturing sector. This is really about the fact that jobs requiring low skill levels are not sustainable for two reasons. First, they are usually jobs that are not particularly healthy and therefore result in significant long-range health issues and costs for the workforce. Second, low-skill level jobs are easily transferable to locations where labor costs are lower. People often think that this means shifting to less developed nations. However, it also may mean that if a country’s currency is devalued, the low-skill level jobs may shift

Efforts to provide outside education and training, as well as raising awareness among the next generation of workers about the opportunities in manufacturing, are important. But astute manufacturers should be investing—proportionally to their need and with all deliberate speed—in training programs for both existing employees and new hires, from broad and transferable skills all the way down to hyper-specific skills that are needed at perhaps only one facility. While there has always been some level of on-the-job training and apprenticeship in manufacturing, the need is more pronounced today and the training required is deeper than before—which may mean that manufacturers should consider greater investment in training (and the people to develop and lead it) than historically has been necessary.

towards that country. Most importantly, this points to the need for a highly and continuously trained workforce. This drives home the point that we need a culture of lifelong learning to ensure that not only is our next generation workforce prepared to support manufacturing, but our current workforce is prepared to support our present and future needs in the manufacturing sector.”

Dr. Thomas Kurfess
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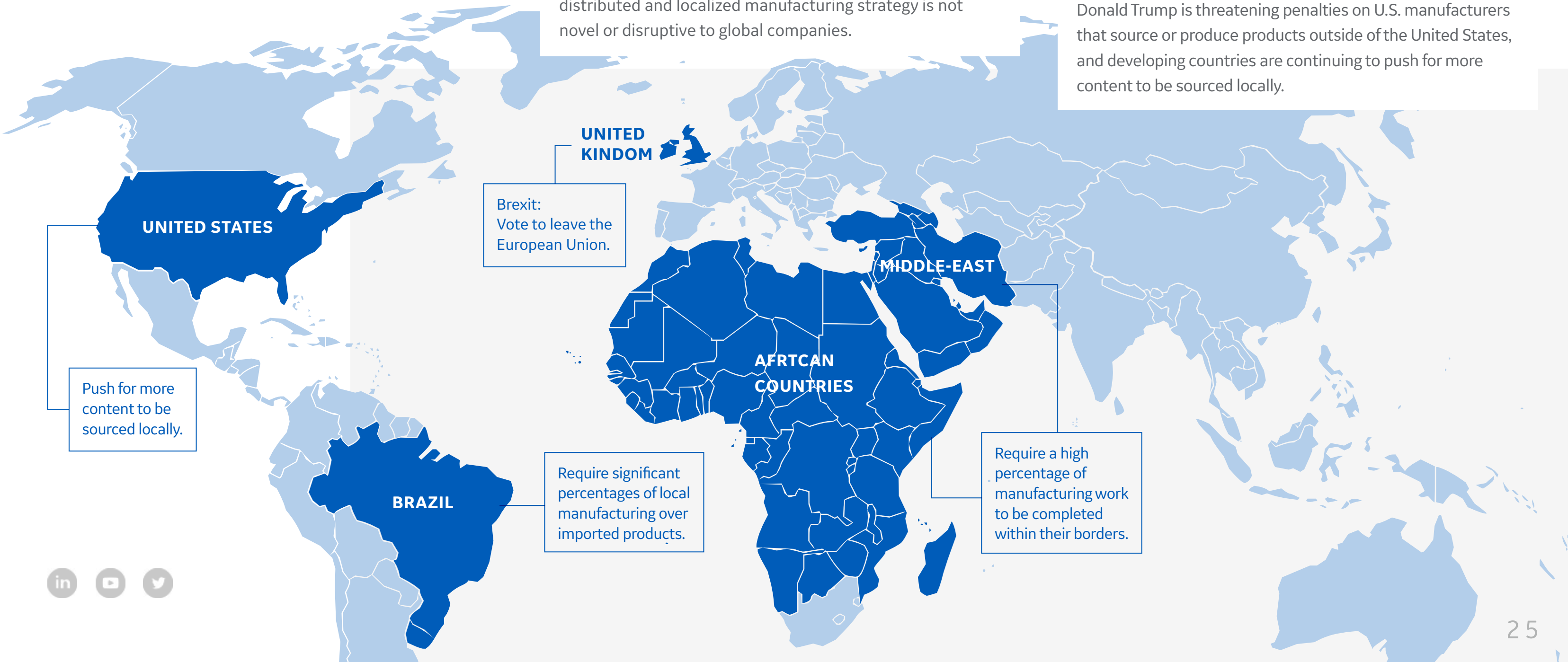
Protectionism and localization

The concept of localization in global business is neither new nor particularly controversial.

Brazil has always required significant percentages of local manufacturing over imported products, for example. Today, many Middle-East and African counties are trying to expand their industrial bases, and are thus requiring a high percentage of manufacturing work to be completed within their borders. So the concept of needing to have a distributed and localized manufacturing strategy is not novel or disruptive to global companies.

But over the past 18 months or so, global politics and rhetoric in both last summer's referendum in the UK on whether to remain in the E.U. and the U.S. presidential election, has brought more attention to protectionism and localization. Leaders on each side of the Atlantic campaigned on promises about closing borders to and raising taxes on imported goods, though it remains to be seen how extensively they will execute on those promises.

Britain is poised to leave the European Union after what became known as the "Brexit" vote, new U.S. President Donald Trump is threatening penalties on U.S. manufacturers that source or produce products outside of the United States, and developing countries are continuing to push for more content to be sourced locally.



Additionally, many governments have used the lever of rising tariffs to impact imports and exports.

In July, 2015, when U.S. Congressional authorization for the Export-Import Bank lapsed, other world governments stepped in to finance projects in its place—but they required that a certain portion of the work be completed within their borders so that the money went to their national economies. This rise of protectionism—some might call it a backlash against globalism—is changing how global companies think about expanding, and where they might locate offices and facilities.

GE CEO Jeff Immelt has promised that GE will continue to be a global company, but suggests that its exports from the U.S. may decline as a result of this rise of protectionism and potential GE moves to localize production.

From this perspective, sustainable growth will require a local capability inside a global footprint—requiring multiple global sites that offer local market access. As Immelt has pointed out, “A localization strategy can’t be shut down by protectionist policies.”

Immelt may be among the more vocal corporate manufacturing leaders articulating this perspective, but he won’t be the last. If the transition to a more localized and less globalized economy is more than temporary, we can expect to see more manufacturing companies emphasizing local production and distribution of heavy manufacturing output. This could provide a boon to local country economies at least at first, as facilities are built or repurposed and jobs are created to populate these facilities. The longer-term impact on imports, exports, and production may take longer to assess, because there are indicators of both positive and negative impact of localization or protectionism on national manufacturing sectors—and on their broader economies. The impact of protectionism and de-globalization on world currencies may affect manufacturing output and sales.



OTHER VOICES

The rise of protectionism or localization and anti-globalization

“The world’s economy is tightly integrated on an international basis, which will make it difficult to enact protectionism at a very large scale. That being said, it is clear that the playing fields in the manufacturing sector have not been level, and those playing fields will need to be leveled over the coming years. Technology will enable and drive this leveling through an increased understanding of production operations, and production capabilities. Concepts that are supported by technical advances, such as point-of-use production, will give rise to more localized manufacture of high value added consumer goods, which will drive more localized production operations. There will be some give and take, and there will be some growing pains, but a more fair playing field is on the horizon for manufacturing at a global level.”

Dr. Thomas Kurfess | **HUSCO/Ramirez Distinguished Chair in Fluid Power and Motion Control Professor**
George W. Woodruff School of Mechanical Engineering
Georgia Institute of Technology

“With the new administration, it seems clear that we will see renewed incentive for manufacturing to stay and increase in the U.S., which is great news for the job market and the American economy.”

Jim Kosmala | **VP of Engineering , Okuma America**

While the impact of the British vote to leave the European Union is still unfolding, one of the short-term impacts was a decline in the value of the British pound due to uncertainty in the United Kingdom.

This led to better than expected manufacturing output from British manufacturers—it became cheaper to buy British manufactured goods in global markets as the pound declined, which led to increased sales of and demand for British manufacturing. This effect ran contrary to some of the more dire predictions made by economists warning of negative impact from the UK leaving the European Union.

Conversely, the relatively high value of the U.S. dollar has caused the price of American goods to be higher recently in other parts of the world. As a result, industries like aircraft manufacturing may be challenged in upcoming years if they experience fewer orders in 2017 and beyond.

Whether this pattern reverses itself as a result of the trade practices of the incoming administration is yet to be seen—a more protectionist U.S. trade policy could lead to short-term increases in profits and output from U.S. manufacturers as well. It will bear observation to see if other countries retaliate against the U.K. and U.S. with protectionist policies of their own, which could lead to, among other things, a currency war, which might destabilize the entire manufacturing industry until the dust settles.

Heavy manufacturers will do well in 2017 to keep close watch on global trade policies and the spread of the current of localism and regionalism. Embarking on a localization policy that is somewhat immune to protectionism may be the wisest course for international manufacturers, especially if trade or currency wars prove a destabilizing influence.

Manufacturers should also be considering how they manage a more localized supply chain. Digital tools are a promising avenue to help in that regard, and manufacturers should look to these tools to help them achieve these localized supply chains. Digital tools exist that will give them insights into how well assets and systems are performing in all parts of the world; others will aid in planning, scheduling, logistics, and analysis of increasing complex supply chains.

Heavy manufacturers will do well in 2017 to keep close watch on global trade policies and the spread of the current of localism and regionalism.

OTHER VOICES

The state of the manufacturing workforce

“We need our nation’s workforce to evolve into better problem solvers. No matter what your rank is, we need the shop floor, middle management, engineering, sales, IT department, and executives to solve complex problems and look at things differently. It takes a lot of education and awareness, but if done correctly, I believe that the United States has one last chance to become the king of manufacturing.

We’ve abandoned core values after finding that we can send product over to China to be made at a cheaper cost, while simultaneously withdrawing investment in our people and our systems without thinking, “How can we do this here?” If we do the same old same old, we won’t get different results.

As an industry, we’ve grown more capital intensive, and with the use of automation, organization’s don’t need the historical number of people we used to for hard labor, but we need their human capital, we need their brain power. And that doesn’t necessarily mean degreed people, it means the United States needs to incubate a smart, intuitive, and curious workforce of critical thinkers and problem solvers to be systematic in our processes.

The government should focus on understanding what our genius is here and how we can capitalize on that to be a global competitor on all fronts. As we implement automation and take hard labor out of things, we must start using our brains differently.”

Karl Wadensten | President, VIBCO



SIGNIFICANCE

TO OTHER INDUSTRIES

Heavy manufacturing may seem to outside observers to be among the oldest of “old school” industries—but in reality, heavy manufacturing is a harbinger of practices that will seep into other industries.

Heavy industry is very diverse and involves what might be called high-value, low-volume products.

For example, gas turbines, large dump trucks, and airplanes all cost millions of dollars to manufacture, and volumes are on the order of hundreds, not thousands, per year. There is a significant cost of entry into any of these product markets, and because of this, there are only a few companies who are able to enter and compete.

Heavy industry products frequently have a significant amount of configuration from product to product. This drives heavy industry manufacturers to be inherently flexible in their operations and processes. As other industries are trying to be more flexible in order to be more responsive to shifts in markets, they may look to heavy industry manufacturing to understand how they are using digital tools and technology to manage flexibility in their processes.



About Andy Henderson, Ph.D.

As an industry analyst at GE Digital, Andy leverages his experience from his time as an advanced manufacturing engineer within GE Power and his research during his doctoral program to promote a vision for the future of heavy industry/discrete manufacturing and drive strategy for achieving that vision.





About GE

GE (NYSE: GE) is the world's Digital Industrial Company, transforming industry with software-defined machines and solutions that are connected, responsive, and predictive. GE is organized around a global exchange of knowledge, the "GE Store," through which each business shares and accesses the same technology, markets, structure, and intellect. Each invention further fuels innovation and application across our industrial sectors. With people, services, technology, and scale, GE delivers better outcomes for customers by speaking the language of industry.

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