

3rd ANNUAL STATE OF Manufacturing Technology

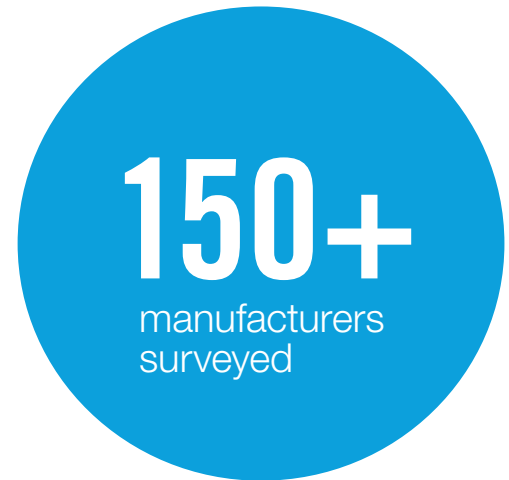
THE FOURTH INDUSTRIAL REVOLUTION IS POWERED BY CONNECTED MANUFACTURERS

Manufacturers today are driving a generational shift in how things are made around the world, from concept to customer and from the shop floor to the top floor. For the third year running, Plex Systems has surveyed hundreds of manufacturing leaders. This has allowed us to share how and why industry drivers are using technology to improve business processes and operations, from the use of connected devices on the shop floor, such as IP-enabled tools and consumer tablets, to the collection and application of data analytics and supply chain planning tools. Based on the results of this year's data, one thing is clear: leading manufacturers are not on the cusp of the fourth industrial revolution—they've already arrived.

The State of Manufacturing Technology (SoMT) Report provides insights on how manufacturers are using technology to drive business processes and improve operations from the shop floor to the office of the CEO.

This report surveyed more than 150 participants, representing an increasingly diverse set of industries including everything from automotive components to industrial equipment, aerospace, food and beverage, high technology, and plastics.

Respondents report they are strong and growing: more than 80 percent have achieved revenue growth in the past five years. And the top manufacturers continue to set the pace for the broader industry, with 14 percent reporting growth in excess of 51 percent. Contrary to popular assumptions, manufacturing continues to be a vibrant component of both the U.S. and global economy, with advanced manufacturing technology playing a pivotal role in competition, innovation, and job creation. While respondents are all U.S.-based businesses, close to 30 percent operate facilities in Mexico and more than 15 percent report facilities in Europe and Asia. Industries represented in the study include automotive, metals, food and beverage, aerospace and defense, high tech, and industrial equipment.



Contents

IT'S HERE NOW: THE FOURTH INDUSTRIAL REVOLUTION	3
CLOUD COMPUTING IS THE FOUNDATION FOR CONNECTED MANUFACTURING	6
CONNECTED MANUFACTURING: A FOUNDATION FOR INNOVATION	9
BIG DATA AND ANALYTICS GROUND DECISION-MAKING	16
RISKS TO GROWTH	18
TECHNOLOGY IS KEY TO FUTURE MANUFACTURING	21



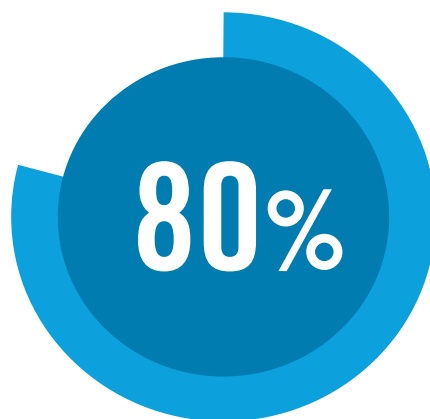
**IT'S HERE NOW:
THE FOURTH INDUSTRIAL REVOLUTION**

While some profess the fourth industrial revolution (4IR) will be a gradual process taking place over the next several decades, our survey findings and first-hand experience working with manufacturers indicate a different timeline. We're already seeing industry leaders take advantage of technologies that combine the physical and digital to disrupt markets, accelerate innovation, and transform customer relationships.

Across industries, we are witnessing a fundamental disruption in manufacturing. Customer expectations for customization and collaborative innovation have sky-rocketed. Demand signals, which were traditionally steady and predictable, have become a buzz of real-time imperatives. And while efficiency and quality are still core requirements, speed and agility have become new standards for industry leadership. Leading manufacturers look for competitive advantage across every aspect of their market opportunity, every day, including customer demands, locations, materials, supplier performance, logistics and distribution, inventory, product performance, and even workforce skills. It is this drive that is fueling the next revolution.

As a group, manufacturers look to technology as the foundation for both the product and operational transformation that forms the 4IR; 80 percent of respondents in 2017 said technology was either important or very important to their own ability to innovate.

In review of the survey findings, there are a number of major factors that emerge as the foundation for the 4IR. Without question, cloud computing has been a universal accelerant for this innovation, supporting connected processes that extend across the shop floor and out into broader customer and supplier ecosystems. With cloud comes connectivity, enabling everything from tighter links across production ecosystems to better system, equipment, and end-product integration. Every day, new devices and equipment, both those designed specifically for manufacturing and those conceived for other industries or even consumer markets, are providing new opportunities for innovation and connection. From additive manufacturing (3D printing) to connected sensors and wearable devices, the Industrial Internet of Things (IIoT) is delivering new endpoints to enhance the ways we design, build, sell, and service products.



of respondents in 2017 said technology was either important or very important to their own ability to innovate.

“Manufacturing as we know it is being redefined each day, thanks to technology. We’re now able to look at significant industry shifts and combine them with cutting edge innovations to develop practical solutions that drive transformational change on the shop floor. By partnering and working hand-in-hand with our customers, we’re exploring the viability of everything from advances in mobility with advanced wearables to machine learning for measurable operational and business improvements.”

– JERRY FOSTER
Chief Technology Officer



CLOUD COMPUTING IS THE FOUNDATION FOR CONNECTED MANUFACTURING



of respondents are using cloud-based productivity applications, double the number in 2016.




Since we began surveying manufacturers three years ago, the cloud has moved squarely from “what’s next” to “what’s now.” As the technology backbone of next-generation manufacturers, cloud computing and software-as-a-service (SaaS) have delivered two transformational opportunities. First, cloud computing fundamentally changes the cost model for business systems, enabling even small- and mid-sized manufacturers access to enterprise class operations: 97 percent of survey respondents said that cost reduction was a somewhat or very important component of their cloud deployments.

Second, cloud has delivered a new era in connectivity, making it both simple and inexpensive to strategically and tactically link systems, people, organizations, machines, and devices to an ever-expanding network: 96 percent of respondents cited connectivity as an important or very important benefit in our 2017 survey. This is true for both strategic applications like ERP and MES, as well as tactical solutions such as Dropbox for cloud file storage and Microsoft Office 365: 90 percent of respondents are using cloud-based productivity applications, double the number in 2016.

At a macro level, this survey finds customers connecting the cloud to specific improvements in manufacturing business processes. More than 70 percent of respondents note that cloud has positively impacted their ability to manage fluctuating customer demands. As the manufacturing industry continues to shift toward more collaborative, just-in-time models, the inherent connectivity in the cloud is already achieving dividends.

More than half of respondents draw a direct line between cloud solutions and improvements in the management of global supply chain activity. This comes as no surprise, as supply chain planning is almost ideally aligned with cloud’s core capabilities. Cloud solutions are designed to be accessed anywhere and to easily integrate, making it simpler to collect and analyze real-time data and easier for analysts both within and beyond the enterprise to connect.

As we observed within many connected enterprises, cloud technologies also contribute significantly to top line opportunities. Nearly all respondents, a whopping 98 percent, said they value cloud-based systems for their ability to support continuous innovation.



CUSTOMER SPOTLIGHT

TRANSFORMATION THROUGH: Cloud

MANUFACTURER: Clips & Clamps Industries

INDUSTRY: Precision Metalforming

Moving to cloud ERP helped Clips & Clamps Industries, a family-owned metalforming manufacturer serving the automotive industry, from duplicating data entry across seven siloed software systems. Once the company implemented the cloud, employees gained access to a connected enterprise through one integrated system. Employees stopped having to enter the same data into multiple systems, adding up to fewer process disruptions and better use of resources across the company.

What's next:

The secular shift to the cloud is hitting its stride, but the carry-on benefits are just starting for manufacturers. While these solutions were initially deployed to improve basic functions like inventory and quality management, organizations are leveraging the underlying efficiency and connectivity of the cloud to reach into new opportunities. Numerous organizations we speak to are driving paperless shop floors using a mix

of industry-specific and consumer devices to support their workforce. Companies are also digging deeper into machine telemetry, looking for insights in data that can point to equipment and process performance improvements, improving quality and bottom line results. These data elements, while always present, have been out of reach based on operational priorities. That's changing.

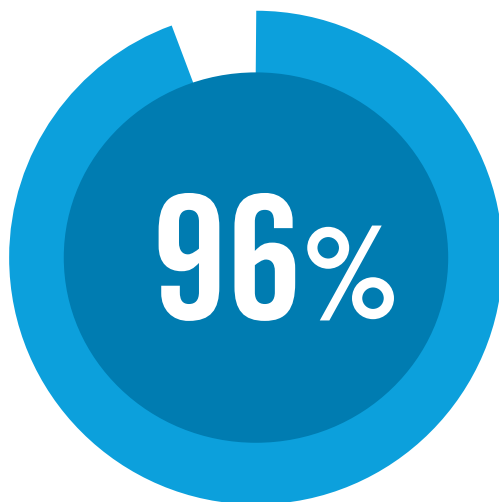


**CONNECTED MANUFACTURING:
A FOUNDATION FOR INNOVATION**

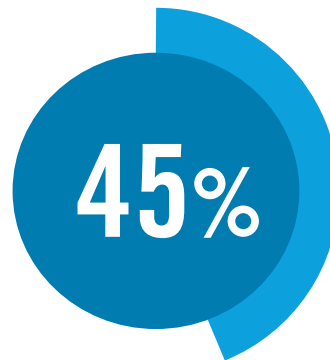
Since the first production lines and Henry Ford's vision for a fully integrated factory, the connections between people, processes, machines, and products have been huge levers for manufacturers in their efforts to innovate with quality and efficiency.

Today's manufacturers are taking connectivity to the next level, linking every aspect of their operations and supply chain into a fully-orchestrated network. These networks are the enabling platform for the 4IR because their efficiency and effectiveness open new opportunities for investment and innovation. Additionally, the omniscient nature of the cloud (anything can be connected, anytime) offers a new realm of insight that spans from equipment and process performance to suppliers and to end products in use. Never before have business leaders had such a powerful mechanism for tuning and guiding their operations.

What's exciting about this survey is that many leading manufacturers are demonstrating connected manufacturing operations: 96 percent of survey respondents note that improvements in connectivity to systems, machines, suppliers, and customers comes as a direct result of cloud systems. Seventy-one percent cite the positive impact of cloud systems on their ability to deal with fluctuating customer demand and a further 45 percent tap the cloud as an important contributor to their own new product introductions.



note that improvements in connectivity to systems, machines, suppliers, and customers comes as a direct result of cloud systems.



tap the cloud as an important contributor to their own new product introductions.



CUSTOMER SPOTLIGHT

TRANSFORMATION THROUGH: Innovation

MANUFACTURER: Sanders Candy

INDUSTRY: Food and Beverage

Since candy and baked goods company Sanders Candy implemented Plex, company leadership has used the resulting increased shop floor visibility, control and quality to transform the 142-year-old company. Leaders have been able to innovate new products, which has opened up new markets locally and globally. The main manufacturing location has also seen many changes to its plant floor in recent years, and in fall 2017 will complete a major renovation to accommodate its growing business and customer base.

CONNECTED MANUFACTURING ON THE SHOP FLOOR

To say that IIoT has captured the imaginations of business, technology, and manufacturing professionals is an understatement. Countless articles, stories, and books have been written on the topic. IIoT is a cornerstone in the realization of the 4IR, so we sought to better understand exactly which connected devices manufacturers are using today, and expect to use in the years ahead.

More than half of respondents have improved machine integration, broadly, using cloud technology and 74 percent have improved connectivity with mobile and personal devices.

The use of robotics is exploding among surveyed manufacturers. Since 2016, we saw a 25 percent increase in deployments, with three out of every four manufacturers now using robotics in their manufacturing operations. While robots have had a major role in manufacturing since the 1950s, they continue to expand rapidly into Tier One and

mid-sized organizations as prices drop and equipment becomes even easier to program and configure for unique operations.

Additive manufacturing and 3D printers saw an eight percent increase as these incredible devices pass through their own hype cycle and into the mainstream. Still widely used for prototyping, additive equipment over the long term still holds the promise of a direct connection between concept, design, and manufacturing execution. Parts for complex assemblies, even for airframes, are now constructed with additive equipment so it is reasonable to expect adoption to accelerate from this point.

Sensors and IP-enabled tools and machines are also being employed by more than 50 percent of surveyed manufacturers in 2017.

Mobility and human interfaces continue as a major focus for manufacturers. Enabled by the inherent connectivity of cloud systems, organizations are increasingly leveraging consumer mobile devices to support people in every facet of businesses from the shop floor to the loading dock and the head office. More than 30 percent (our top response) plan or are in the process of deploying consumer tablets in their organization, and we've watched multiple large manufacturing operations move aggressively to paperless operations in this way. The survey also shows an increase in the adoption of wearable devices. The use of smart watches alone has doubled each year since we began this survey, in spite of somewhat limited sensors and feature sets. The cost of these new devices, coupled with easy connectivity, has led to extensive experimentation with each new consumer offering.

Even when we look at emerging technologies that are perhaps more hype than reality, manufacturers still have aggressive plans. More than a quarter of manufacturers still plan to implement smart wearables—such as Microsoft HoloLens and Apple Watches—within the next five years.

Ultimately, mobile user support is now ubiquitous for manufacturers. The use of mobile phones, laptops, and hand scanners, popular with 90 percent of surveyed manufacturers, remains consistent year-over-year. And we are seeing a consistent sentiment among manufacturers that the cloud's ability to integrate with personal devices is a benefit to the organization. A full 80 percent of manufacturers agreed that integration has improved as a result of cloud-based software.

CONNECTED SUPPLY CHAIN

Supplier and customer relationships are fundamental to manufacturing. High efficiency and optimal quality on the shop floor matter little if raw materials are scarce or substandard. Availability of products is not the same as on-time delivery.

At the highest level, 60 percent of manufacturers deploying cloud-based systems to run their operations report improvements in communication and connectivity with customers. These links can range from EDI to e-commerce, but they reflect the cumulative value of connected systems. Nearly 80 percent of our respondents have improved insights into data using the cloud. An organization that has real-time telemetry from suppliers,

machines, people, systems, and products can not only communicate more effectively with customers, but it can also do so with speed and accuracy. Similarly, 70 percent of organizations reported improvements to communications with their own suppliers, whether through integrated systems or supplier portals.

Ultimately, this is reflected in supply chain performance: 60 percent of respondents noted improvements in their overall supply chain performance as a direct result of cloud systems. Again, this reflects an aggregate benefit that starts with enterprise-wide connected manufacturing, more accurate and real-time access to data, and improved (standard) communications mechanisms to keep all members of an ecosystem informed.

“Cloud technology provides real-time information and visibility into the supply chain, allowing manufacturers to be more proactive as well as more flexible to adjust to changing demands. This gives manufacturers the ability to focus on reducing lead times, not only in the supply chain but also in the product development cycle—which in turn reduces time to market and increases competitiveness.”

- **MONTI PICCIONI**
Principal, ERP Consulting
Plante Moran

CUSTOMER SPOTLIGHT

TRANSFORMATION THROUGH: Supply Chain

MANUFACTURER: ASK Power

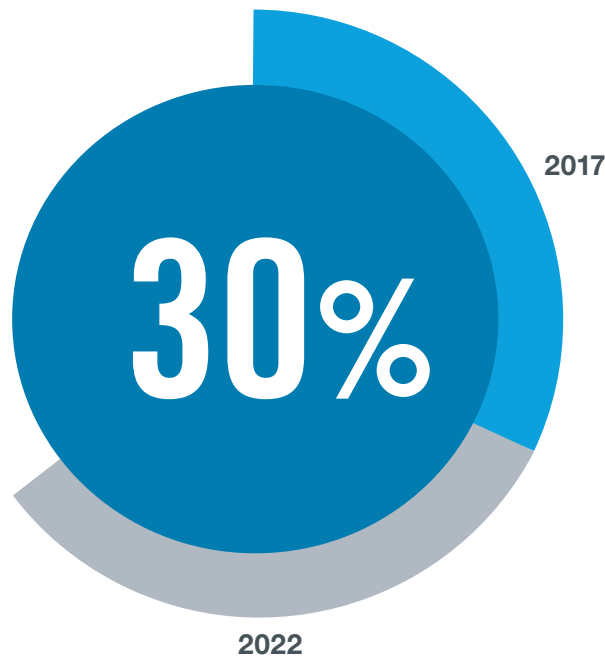
INDUSTRY: Industrial Manufacturing

ASK Power, a terminal lug manufacturer and supplier, had a problem: By the time it had completed its monthly forecasting, it was already out of date. A similar challenge confronted the team when it came to shop floor control, particularly capacity planning, and current job status. An opportunity to fill a market gap left by a competitor was good news for sales, but the increased demand only exacerbated the issue. The solution? Capacity planning and sales and operations planning (S&OP) software. Integrating easily with existing ERP system, supply chain planning allowed the company access to near real-time data, allowing them to plan for the future 45-60 days out. As a result, ASK Power's profit margin went from 2 to 10 percent, its on-time performance to 99 percent, and lead time from five to six weeks down to two to three weeks.

What's next:

Connections on the shop floor continue to proliferate. In interviews with leading manufacturers that have already deployed connected solutions, there is regular and focused planning to add more devices and sensors, and thereby more data, to their enterprise backbone. Efforts include better informing mobile workers on the shop floor, but also mining deeper into machine data to improve and extend the performance of equipment and shop floor consumables.

The connected supply chain is expected to explode, with more than 30 percent of respondents focusing on it today and another 30 percent expecting to employ new technology in the next five years. Similarly, more than 30 percent are expecting to integrate sales and operations planning within the next five years. This is a significant shift when compared to just three percent focused on new supply chain management technologies in 2016. We regard this as a shift that builds directly on the connected manufacturing enterprise, access to rich, real-time data, and enhanced integration capabilities.



The connected supply chain is expected to explode, with more than 30 percent of respondents focusing on it today and another 30 percent expecting to employ new technology in the next five years.

“There’s little doubt supply chain management is the next biggest opportunity for manufacturers to become more operationally efficient and profitable. A connected supply chain delivers improved planning, lending to more strategic decision-making and the ability to compete more effectively. When combined with emerging technology innovations such as machine learning and predictive forecasting, manufacturers taking on this initiative and refining solutions suited to their needs now have the most to gain.”

– ARA SURENIAN
Supply Chain Product Management, Plex Systems



BIG DATA AND ANALYTICS GROUND DECISION-MAKING

A major component of the 4IR is the expectation that organizations and products will be transformed. Products will become services, and insight from end users and the products themselves will instantly become part of the continuous innovation cycle. This is already happening.

Twice as many manufacturers are using analytics today than last year, with more planning implementations over the next five years. As has been true across most technology adoption cycles in manufacturing, the first deployments have been focused on core productivity and efficiency. Manufacturers today cite analytics for predictive maintenance as their top application followed by supply chain risk management.

And analytics now stretch from machine data to supplier scorecards and product quality. In a number of interviews, manufacturers have reported new levels of telematics built into their own products, providing data back to the manufacturing operation that can be analyzed in combination with insight from within the enterprise.

What's next:

Connected manufacturing makes data collection and aggregation easier than it has ever been in history. We anticipate organizations will continue to rapidly expand their use and leverage of structured and unstructured data. This is a direct outcome of the inherent connectivity of cloud solutions, coupled with the exponential growth in sensors, smart products, and external sources being added to the

ecosystem. And that data and associated insight can now be delivered to any participant in the ecosystem, at any time. Leading organizations understand this: half of the organizations in our survey are looking for data analysis skills in their future workforce.



twice as many manufacturers are using analytics today than last year.



RISKS TO GROWTH



CUSTOMER SPOTLIGHT

TRANSFORMATION THROUGH: Workforce Skills

MANUFACTURER: Trojan Battery

INDUSTRY: High Tech and Electronics

Trojan Battery, the world's leading deep cycle battery manufacturer, has a cloud-first strategy. When initially making this significant shift as an organization, it found that it needed to take a measured approach to training its workers to ensure they had the skills to effectively use the system without disrupting delivery to customers. The company's approach was to appoint 25 well-respected leaders cross-department to learn cloud ERP, document the process and then train their people over a 10-month period. According to Director of Information Technology Matt Irely, disruption calmed down after just one month, demonstrating that a combined cultural and technical approach can pay off big for manufacturing organizations developing the skills of their workforce on-site.

Dynamically changing the manufacturing industry, and the way it makes and delivers things doesn't come without challenges. Our survey respondents have shared that both the workforce and the skills they're developing are critical to manufacturing growth, while also posing its greatest risk.

It's well documented that a skilled workforce prepared to keep up with the recent advancements in manufacturing is lacking, industry-wide. According to the Manufacturing Institute, it's expected that 3.5 million manufacturing jobs are going to need to be filled in the next decade, with a staggering two million of those jobs expected to go unfilled.¹ This gap is being attributed to both baby boomer retirements, and

something that we're seeing with our own survey respondents—economic expansion.

Nearly 35 percent of survey respondents believe a shortage of skilled workers will be their top challenge to company growth in the next year alone. The skills these workers will need are unique to the organization and broad, but respondents generally believe the next generation of employees will have to have lean manufacturing (68 percent), mechanical engineering (48 percent) and data analysis (48 percent) skills.

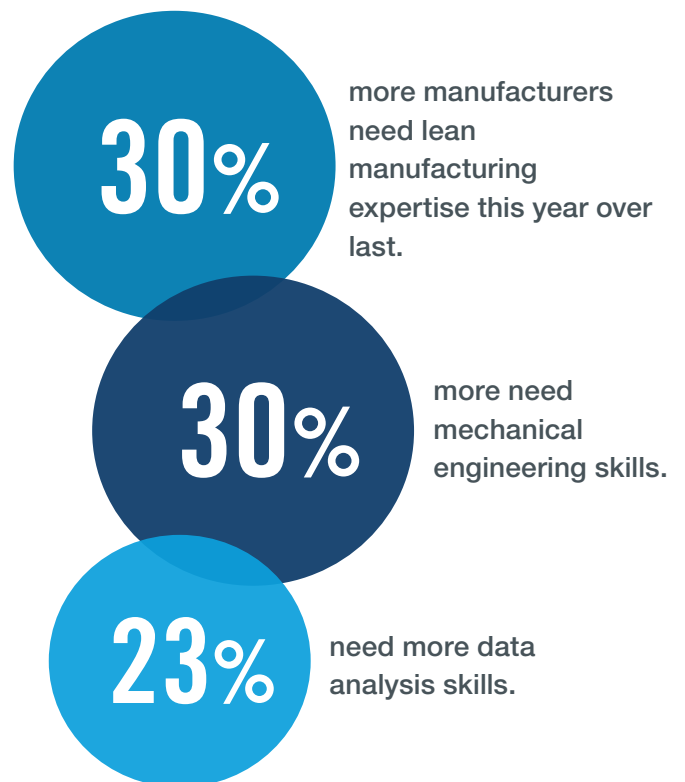
While these three skills echo the top three responses in 2016, what's different is that we're seeing double digit increases in the needs for these skills among manufacturers. A full 30 percent more manufacturers need lean manufacturing expertise this year over last; 30 percent more respondents need mechanical engineering skills; and 23 percent need more data analysis skills. Data analysis skills needs tie directly to the growing value of big data and analytics among manufacturers, as seen earlier in the survey.

Other risks concerning manufacturers on a smaller scale are weak demand, with 18 percent of survey respondents concerned about demand among U.S. customers specifically. Another 17 percent of respondents are concerned about lower-cost competitors, indicating profit margins will continue to be squeezed by end-users.

What's next:

There's a reason why initiatives like the annual Manufacturing Day are growing in popularity. This year alone, there are already 550+ registered events planned across the U.S. for manufacturers to open their doors and inspire the next generation of manufacturing workers, with some of our own customers also getting involved.² While there are several risk factors manufacturers are monitoring and managing, skills should and will remain a primary concern. With recent favorable jobs reports and unemployment in July down to 4.3 percent across the U.S., filling jobs is becoming even

more competitive. As a result, developing the future skilled workforce will require more time, energy, and engagement for manufacturers to secure their futures.






**TECHNOLOGY IS KEY TO FUTURE
MANUFACTURING**

Manufacturers have been among the most eager and innovative users of advanced technologies throughout each industrial revolution, whether in processes, products, or across ecosystems. Connected manufacturing is among the most powerful technology-based shifts in a generation, no less important than the arrival of steam power, electricity, or the automated production line. In each of those cases, a singular technology led to thousands of incremental positive changes across the industry.

Connected manufacturing has rapidly achieved similar status. Witness the speed at which organizations are moving to completely paperless operations, swapping in low-cost consumer devices in roles that used to require highly-specialized equipment.

Companies that are using the cloud to connect business processes, people, suppliers, and customers are seeing that one version of the truth, real-time data, and increased enterprise visibility are paying off in genuine business growth. More than a third of manufacturers in 2017 attribute their revenue increases to technology.



CUSTOMER SPOTLIGHT

TRANSFORMATION THROUGH: Connected Technology

MANUFACTURER: Fisher & Company


INDUSTRY: Automotive

The emergence of Google Glass, Enterprise Edition, is old news to manufacturer Fisher & Company which began using the technology on its shop floor in 2015. The company combined the use of Google Glass with Estimote Beacons and ring scanners to connect even more devices into the cloud. The agility of a cloud-based system has allowed the automotive supplier to continue to explore new ways to improve processes which have given Fisher a competitive edge.

Manufacturers' investments in innovations aren't just changing the way things are made across the planet. As proponents of the 4IR projected, technology is once again acting as a catalyst for change across entire industries, transforming ecosystems, and providing new platforms for further innovation. And supply chains, like the rest of manufacturers' businesses, will continue to undergo transformation through the use of connected technologies, which are delivering more relevant data, and changing the way manufacturers leverage their workforce, facilities, and extended ecosystem most effectively.

Finally, when it comes to the workforce, while technology is making enormous gains for manufacturers, it's still about the people. The current skills shortage in manufacturing is a rising challenge that requires not only concerted private-public partnership on education, but also investment in efforts to promote the extraordinary career opportunities available for young people.

It's an exciting time to be in the manufacturing industry, with manufacturers who are embracing technology truly defining the fourth industrial revolution as we know it.



“Domestic manufacturing will only continue to get more competitive and challenging. Manufacturing enterprises that adopt Industry 4.0 models—which expand connectivity and support additive printing for prototyping and small lot manufacturing—will lead the way. These models, along with leading industrial analytics, will drive efficiencies and reduce time to market faster than ever before.”

- **PETER J. PEARCE**
Principal, Baker Tilly

ABOUT PLEX

Plex is the Manufacturing Cloud, delivering industry-leading ERP and manufacturing automation to more than 550 companies across process and discrete industries. Plex pioneered cloud solutions for the shop floor, connecting suppliers, machines, people, systems and customers with capabilities that are easy to configure, deliver continuous innovation and reduce IT costs. With insight that starts on the production line, Plex helps companies see and understand every aspect of their business ecosystems, enabling them to lead in an ever-changing market. Learn more at www.plex.com.

References:

1. Giffi, Craig; McNelly, Jennifer; Dollar, Ben; Carrick, Gardner; Drew, Michelle; Gangula, Bharath. The Skills Gap in U.S. Manufacturing: 2015 and Beyond. Deloitte and The Manufacturing Institute. 2015.
2. Manufacturing Day 2017. Founding Partner Fabricators; Manufacturers Association International; National Association of Manufacturers. <http://www.mfgday.com/>