

Wins Earned, Lessons Learned & New Paths Charted...

Peer into the near future of manufacturing with our 2020
Digital Transformation Crystal Ball Report.



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What do lettuce and carrots have to do with the IIoT?

By Michael Kanellos, IoT analyst with OSIsoft

1. **IoT emerges from the Trough of Despair.** IoT projects are often portrayed as the quickest way to get yourself fired. Have you heard the “fact” that three fourths of them fail? In reality, success is the norm. Gartner’s Eric Goodness conducted a poll that 57% are achieving outcomes better than anticipated with only 3% not meeting outcomes. Ian Hughes at 451 Research says around 7% have achieved negative ROI. Either way, we’re talking single digits. Why the turnaround? Better technology for one, but also companies are scoping their projects more appropriately.
2. **The pay-per-view business model arrives.** Some large industrial customers track millions of data streams. Even a single wind turbine can generate more than 93,000 signals a day. Thus, traditional “by the gigabyte” cloud models don’t work; people may not need all of the data being generated, but they don’t know what they need until later. Some software companies have unleashed programs where customers can store large amounts of data in the cloud, but only pay for what they use.
3. **Edge gets a sharper focus.** IDC and Gartner now predict that between 40-75% of data may exist outside of cloud data centers. So what is the edge? In a word, an on-premise data center, or at least one that’s within walking distance of your facility. It’s not going to be cost-effective to send everything to the cloud and the need for low latency and resilience in some networks far outweighs the cost of running a local data center. The big difference between the data center you have now (and IT has suggested you phase out) and an edge data center is that there is a higher likelihood that it will be owned and managed by a third party.
4. **More stick, less carrot.** The International Maritime Organization has mandated that ships reduce the sulfur content in their fuel from today’s 3.5% to pricier ones in the 0.5% range next year. (The average tanker ship can consume 250 tons of bunker fuel a day, my colleague Matt Miller tells me, and fuel can represent 30% to 50% of their operating expenses.) To survive, many will turn to IoT to boost mileage. Onshore refiners, meanwhile, will shift to flex-processing strategies partly enabled by analytics and IoT: by micro-monitoring processes, refiners can more easily change feedstocks. Power and water utilities are also under more scrutiny. In the US, the Food Safety Modernization Act is prompting IoT investments. The added bonus: once compliance-inspired systems are in, they can be employed for energy efficiency or other IoT applications.
5. **Data is the new lettuce, replacing data is the new oil.** Why? Because data wilts fast and you have to wash it before you consume it.
6. **Microsegmentation will enter your vocabulary.** Break-ins are inevitable. A new wave of research will concentrate on limiting where hackers can go once inside.
7. **The wireless war of words begins.** 5G. Sigfox. LoRa. Class...discuss. ■

Five (human) predictions for the future of manufacturing in 2020

By Dr. Simon Kampa, Senseye founder & CEO

**I must start this piece with the usual caveat that the challenge of accurately predicting the future of the manufacturing sector is significantly more complicated than it is to identify emerging problems with industrial machinery.*

□ When it comes to analyzing large numbers of production assets, we use critical industrial data stored in factory historians and IoT platforms, combined with sophisticated, self-improving machine-learning algorithms. These are powered by deep condition-monitoring expertise and

provide unique insights into the health of each monitored machine.

Doing so allows our customers to anticipate future problems.

But while this task makes use of plentiful quantitative information and cutting edge AI, predicting the future of manufacturing requires more qualitative insight and is prone to more of the vagaries of human interpretation.

Nevertheless, ongoing conversations with scores of large industrial organizations, including several of our Global Fortune 500 clients, informed our predictions for 2020. We are confident that our top five

predictions for the manufacturing sector in 2020 will provide some useful indication for what to expect.

1. Leaders will emerge in the IIoT-platform market. We expect to see a degree of consolidation in the IIoT platform market, as clear leaders in the space start to emerge during 2020. Industrial organizations will coalesce around a handful of providers over the next two to three years as the various choices become tried and tested. Siemens, OSIsoft,



“2020 will be the year large industrial organizations get smart about the data they gather from their operational environments.”

— Dr. Simon Kampa

and PTC all have robust offerings and are likely to do well. FANUC, a new player entering this space, is set to deliver a strong platform in 2020.

2. Greater focus around operational-data gathering. 2020 will be the year large industrial organizations get smart about the data they gather from their operational environments. Manufacturers recognize now that they need consistent, meaningful and comparable data sets to optimize their production processes. They are

moving away from wasteful practices that involve gathering all the data they possibly can and looking for new sources of meaning and value in these vast unstructured sources. Their focus has moved to specific data sets, such as asset-condition indicators, that industrial organizations can be sure will add value.

3. Early return on investment for servitization. The move toward servitization will gather pace in 2020 as manufacturers move away from product-centric

business models to bundled product-and-service ones. We expect to see some real progress in this direction over the next 12 months, with OEMs taking over more aspects of their industrial customers' machine-monitoring and maintenance activities.

4. More large-scale deployments for predictive maintenance. Adoption of data-driven predictive maintenance (PdM) best practices will reach an inflection point in 2020. PdM-specialized software

applications have already shown to be a compelling solution for Industry 4.0 adopters through a wide range of low-scale implementations and proof-of-concept work. More and more of these limited early deployments are now delivering impressive results and ROI. PdM applications will become a mainstream maintenance solution for larger industrial organizations as they are expanded factory-wide in 2020.

5. Industrialists ask culture to catch up with technology. And finally, 2020 will be the year in which large industrial organizations look seriously at how their maintenance culture could be limiting the potential for Industry 4.0. New technologies have proven themselves to be incredibly powerful in the quest for higher productivity. The falling costs of these offerings and potential ROI mean that the

only obstacle to real digital transformation today is fear of change or lack of frameworks to transform existing approaches. Leaders will increasingly seek the support of vendors when engaging their workforces around the need for change and exploring how technology can enhance (rather than replace) the roles that people play. □



How the IIoT will help manufacturers in 2020

By Sam Cece, Founder, president, & CEO of Swift Sensors

□ The IIoT will have a big impact on industrial productivity and cost savings in the year ahead. Already, 62% of the industrial-manufacturing sector is using IoT technology in operations, and that number is almost sure to rise in the coming months. That's why it seems like everyone's talking about the IIoT right now.

However, not everyone is talking about it the same way.

Technology fans, analysts and the media often focus on IIoT devices' technical specifications and capabilities, which are fascinating and exciting. However, the managers I talk with at plants around the country focus on how internet-connected

sensors can solve the specific problems they face.

Based on those discussions about their goals, here's how I think the IIoT will help manufacturers in 2020.

PREDICTIVE MAINTENANCE WILL REDUCE DOWNTIME

A lot of manufacturing plants have a major maintenance challenge: equipment that's been in use for decades. When these aging compressors, condensers, conveyors and motors break, manufacturers often have to fabricate replacement parts on-site because no one stocks them anymore. When breakdowns happen without warning,

line stoppages can last for days or weeks until new parts are made and installed.

Predictive maintenance (PdM) enabled by remote wireless sensors can alert managers whenever a machine is operating outside its normal parameters. By predicting failure well ahead of time, this IIoT application gives companies advance notice to start fabricating replacement parts. That can reduce unplanned shutdowns and increase uptime by up to 20%, according to Deloitte. Over time, as the sensor network collects more data for analysis, the predictions become more refined and precise, allowing for even better planning.



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— Sam Cece

SENSORS WILL SUPPORT THE TRANSFER OF WORKER KNOWLEDGE

One way that factories without PdM try to stay ahead of equipment failures is by using the insights of their most experienced people. There's a generation of factory workers who've been on the job for two or three decades. Some of these people know the equipment they work with so well that they can diagnose problems by sound.

Now many of those workers are reaching retirement age, and that poses a problem. How do

you transfer sensory knowledge about individual pieces of equipment—insights that took years to develop—to new employees before that knowledge is lost?

Wireless sensor data can help. For example, new hires can shadow senior workers to learn how they monitor and manage the equipment. During that time, the newer worker gets two sets of information about how the machines operate. The first is from the senior worker, who can diagnose equipment by changes in sound or vibration. The second is from the machine's sensor data.

By correlating the sensor data with input from senior workers, new hires can see what the sensor readouts look like when equipment is working well and when there's trouble brewing. This can help bridge the knowledge gap between soon-to-rotate employees and newer team members, preventing breakdowns and reducing unplanned downtime.

TRACKING ASSETS WILL BE EASIER AND MORE COST EFFECTIVE

The ability to track asset locations with low-cost IIoT sensors will

help food, pharmaceutical and other manufacturers who need to monitor products in transit. Tracking can also help plants safeguard valuable equipment. For example, an aerospace manufacturer uses remote wireless sensors to track the location of its specialized mobile presses that move between fabrication stations inside the factory.

IDENTIFYING AREAS FOR EFFICIENCY GAINS WILL BE SIMPLER

Triaxial-vibration sensors can monitor moving equipment for predictive maintenance. They can also show how much each piece of equipment is being utilized. One client was debating whether to purchase another costly piece of equipment, but with vibration sensors installed, they were able to see that equipment utilization varied widely between shifts. With that data, managers were able to work with shift leads to resolve the

issue without a multimillion-dollar expenditure.

5G WILL ADD MORE IIOT CAPABILITIES—EVENTUALLY

It may not happen in 2020, but once 5G is fully operational, edge computing will change the sensor-network game. When the 5G network is strong and comprehensive I think we'll see a wave of new devices that deliver more precise tracking and clearer sensor readings over a larger network.

CUSTOMERS WILL DRIVE USE CASE DEVELOPMENT

As powerful as IIoT technology is, it's manufacturers who are driving new IIoT applications in plants. They're the ones developing use cases for equipment utilization, knowledge transfer and more. Plant managers are the ones looking for ways to prolong the life of their existing equipment so they can postpone expensive replacement projects.

Wireless sensors help them achieve those goals first. Then the sensor network may enable an IIoT project.

How?

By deploying a sensor network, managers get real time insight into their business. When they have sensor data to enable predictive maintenance or automate processes like hourly temperature readings, their initial problem is solved. They can do much more with the collected sensor data, and that usually happens when the QA team digs in and starts comparing and correlating data points. Now what started as a solution to one or two problems is an IIoT project—but it's still primarily about getting insights that help manufacturers solve problems.

As more manufacturers install sensors and start collecting data, I expect to see plant managers develop new IIoT use cases based on their needs. That's a trend that we should all be watching closely in 2020 and beyond. □



“With that data, managers were able to work with shift leads to resolve the issue without a multimillion-dollar expenditure.”

— Sam Cece

A look at industrial-workforce needs in 2020

By Paige Marie Morse, industry marketing director for chemicals at Aspen Technology

Some of the world's most entrenched industries have long relied on a seemingly unending pipeline of workforce talent to replenish workers who retire or transition out of their roles. Younger generations of talent eventually obtained the skills their predecessors possessed, plus maybe a few incremental changes, and operations continued running smoothly.

As we move into 2020, we are approaching a shift in this legacy arrangement: a large segment of experienced, industrial talent is about to retire and the professionals coming in to replace them are completely different and often drawn to fields outside of the industrial world.

Industrial companies need to capture the best talent across the globe and make this workforce transition seamless; success will hinge on their

ability to leverage modern technology to solve for three key workforce challenges in 2020.

CLOSING THE KNOWLEDGE GAP

One of the biggest threats of retiring industrial workers is the extensive amount of expertise they're taking with them when they exit the workforce. The loss is more than just industry knowledge—in some cases it's 30-35 years of experience gained at one industrial company...a significant amount of institutional knowledge.

Many industrial organizations might also rely on a single expert to deliver value to them for a key capability or across a span of global operations. It is unsettling to consider what will happen when heavily-relied upon experts decide to retire. How will organizations

cope with losing individuals who are so pivotal to core operations and processes?

Fortunately, expert knowledge and experience can now be retained in modern software, and companies will look to find technologies that enable this in 2020. To be specific, advanced digital solutions capture expert capability and embed it within process and operating models. When organizations have new staff at the control panel in the future, these expertise-rich process models provide guidance and insight to lead them to better solutions. And this competence extends across industrial production, from operations to supply chain to R&D functions, using a broad range of digital solutions.

DRIVING BETTER DECISIONS

Modern technology will lead



“Expert knowledge and experience can now be retained in modern software, and companies will look to find technologies that enable this in 2020.”

workers to better decision-making. For example, process-control models can give guidance to operators about best conditions for production. Prescriptive-maintenance solutions capture anomalies in asset or equipment behavior and enable workers to get ahead of equipment malfunctions, sometimes months in advance, to keep operations running smoothly. These ultimately make for a significantly less stressful work environment, providing continued peace of mind that everything is operating as it should.

Other examples are supply chain solutions that strengthen coordination between planning departments and manufacturing operations. These teams are mutually focused on meeting customer orders, but alignment can be difficult as they operate on different planning timescales and with varying scope from discrete assets to global regions. Enabling better

collaboration by linking tools and communication leads to better decision-making and eases tension as they manage the inevitable disruptions created by volatile markets and varying demand.

Simulation technologies for operator training help get talent up to speed, quickly, and enable better decisions in the long-term. Training processes can be intense in the industrial world as there is often more risk for human error in either operation of machinery or management of complex, multi-step processes. Operator-training-simulation software enables less-experienced workers to learn in a simulated environment that throws real-world scenarios at them, without the real-world implications.

MEETING WORKER EXPECTATIONS

The replacements for retiring industrial workers will be younger, less experienced, not as apt to

devote their entire working life to one organization and will have an entirely different set of expectations about the workplace.

It can be assumed that any new hires coming into the industrial ecosystem are all digital natives, and have an expectation that their place of work will be digitally-enabled. They also expect their work will be enhanced and made more efficient through digitalization, with comfortable user interfaces, user-friendly processes and granular data-visualizations that lead to more informed decision-making.

The expectations of the younger workforce will require organizations to rethink the way they are structured and find areas in which they can apply digital transformation to reshape the work their people do and how they do it. Without these efforts to modernize decades-old processes, industrial organizations will find themselves stretched for top talent in 2020 and beyond. □



“Simulation technologies for operator training help get talent up to speed.”

— Paige Marie Morse

Trends in oil, gas, data science & edge computing

By Greg Slater, general manager and head of sales at Flutura

CONTINUED DIGITALIZATION IN OIL & GAS

Digitalization in oil & gas is moving at a fast pace; the industry is rapidly adopting the latest technologies. The oil & gas industry is systematically deploying solutions to collect all possible information that will impact results. The data is increasingly used to make the process smarter by using AI driven solutions.

5G, EDGE COMPUTING AND INDUSTRIAL GROWTH

We are on the cusp of exponential growth with data adoption. The signs are here. With the arrival of 5G, data transmission is going to increase by 10X. Within two years of 5G, the speed is expected to further increase by 10X. Imagine the data speed of 100X of what we have now. All of the factories, all of the rigs, wells, assets, etc., will have a dynamic digital twin. These high speeds will result in the rapid adoption of edge/cloud computing. The biggest hurdle for oil & gas has

been sub-optimal edge computing, but things are about to change.

OPTIMIZATION OF RESOURCES & THE IMPACT ON THE ENVIRONMENT

Automobile companies are constantly working to optimize their fuel or battery usage. Electric vehicles are growing in number. With so much battery-usage data, algorithms are going to predict what situations enhance battery life, and what causes degradation. Emerging solutions will help reduce the carbon emission per mile further down the road.

TRIBAL KNOWLEDGE ON CLOUD RESULTING IN BETTER PERFORMANCE

Sometimes, individuals possess the kind of knowledge that is so case-based, a machine can't replicate it. But that is now. Tribal knowledge is becoming a part of machines, but with new process-twinning technology, all of these cases will, ultimately, be recorded. This will

protect the acquired knowledge, making it easier to pass on, making the industry as a whole smarter.

DRAG-AND-DROP IN DATA SCIENCE

The days of specialist data scientists are about to end, and the power of data science will soon be democratized. Companies are already experimenting with something called Engineer's Workbench, a drag-and-drop tool for field engineers. Soon, we will see a marriage of hard-core domain expertise with analytics, to bring in more specific results.

VIDEO-FEED HEALTH, ENVIRONMENT & SAFETY- PRODUCT QUALITY

Enhanced video feeds will boost safety in oil & gas by determining factors that otherwise could not be measured (texture, finish, visible defects, etc.) These parameters will also contribute to self-correcting models' ability to determine product quality. ▣

Seven predictions for commercial and Industrial Internet of Things in 2020

By FogHorn's CTO Sastry Malladi, VP of Product Management Ramya Ravichandar and VP of Software Engineering Senthil Kumar

ORGANIZATIONS WILL MOVE IOT PROJECTS FROM PROOF-OF-CONCEPT TO PROOF-OF-VALUE DEPLOYMENTS

IDC anticipates there will be 41 billion connected IoT devices, generating more than 79 zettabytes of data by 2025. This trend will be driven by the expanding quantity and variety of streaming data channels, moving beyond audio, image and video sensors to also include acoustic, acceleration, vibration and others. Training data for artificial intelligence use cases and machine-learning model creation also play a significant role here.

During proof-of-concept (POC) deployments in the last few years, many organizations have confirmed the benefits that IoT can bring to a wide variety of industries; IoT spending is expected to reach \$1.1 trillion by 2025, according to IDC. For example, smart-city initiatives are replacing existing equipment with IoT-enabled, embedded sensors that capture a wide range of data. Armed with IoT data, cities can improve public safety and

security, energy efficiency, traffic management and respond to ever-changing environmental and weather conditions.

In 2020 and beyond, we will see organizations move IoT and IIoT projects from proof-of-concept to full deployments with the goal to increase overall operational efficiency. To move beyond initial POC benefits, organizations will focus on innovative new opportunities, such as edge computing, to drive significant ROI, deliver enhanced operational productivity, and achieve the final proof-of-value phase.

IN ADDITION TO DATA QUANTITY, ORGANIZATIONS MUST IMPROVE DATA QUALITY TO DRIVE ACTIONABLE INSIGHTS

Looking ahead, data processing and enrichment at the edge will contribute to IoT success by identifying and addressing false and inaccurate machine learning models that lead to dangerous machine failures, declining

operational productivity, and significant cost issues.

EDGE-ENABLED SOLUTIONS WILL POWER A MORE SUSTAINABLE FUTURE

In 2020, we will see an increase in edge-computing deployments driving green-tech use cases to minimize carbon footprints. Transport organizations will start deploying edge computing to detect abnormal regen and idling events in real-time to save billions of pounds of CO2 emissions per year. Additionally, oil and gas organizations will deploy edge technologies to monitor flare stack health to understand emissions output. Through sensor fusion technology, edge solutions will help identify issues with compressor health and alert operators about potential regulatory violations. Also, steel manufacturers will look to edge computing to save millions of tons of CO2 emissions by identifying defective parts produced in steel manufacturing as early as possible in the process to reduce scrap and increase yield.

**THE INDUSTRY WILL REFINE
THE DEFINITION OF “EDGE”**

Edge is certainly complementary to cloud, although in the industrial sector, edge greatly enhances the cloud adoption and value. Indeed, over the next year, edge computing leaders will continuously work to evolve and refine answers to questions such as: where is the edge located, what is edge computing; and why is the edge important.

**AUTOMOTIVE
MANUFACTURERS WILL
LOOK TO EDGE COMPUTING**

**TO IMPROVE REAL-TIME
FUNCTIONALITIES AND
ACCELERATE AUTONOMOUS
OPERATIONS**

While fully autonomous vehicle controls are years away, there are many existing edge computing applications now available to enhance the efficiency, reliability and safety of commercial and public transportation. These include vehicle control and safety systems, such as cameras, driver assistance, and collision-avoidance functions that are being added to new vehicles every year.

In the year ahead, rather than relying on remote data centers for critical command-and-control decisions, automotive manufacturers can eliminate safety concerns and fast-track the road to autonomous driving by deploying edge-enabled systems.

**ORGANIZATIONS WILL
EXPERIENCE A SHIFT FROM
CLOUD-ONLY TO CLOUD-
EDGE HYBRID STRATEGIES
TO ENABLE EDGE AI AND
ITERATIVE ML MODELING**

In the next few years, more than

40% of organizations' cloud deployments will include edge computing to address bandwidth bottlenecks, reduce latency, and process data for mission-critical decision support in real-time.

These edge-powered, IIoT projects will extract a realistic view of daily machine operations and work toward a new level of predictability that will dramatically alter the industry landscape as we know

it. In short, in 2020, cloud-dominated solutions will adopt an edge-first (or cloud-edge hybrid) approach to drive significant business value.

ORGANIZATIONS WILL LOOK BEYOND EDGE COMPUTING TO EDGE AI SOLUTIONS TO DELIVER OPTIMAL ROI

Using the power of artificial intelligence at the edge and self-learning

models, in 2020, ML models can move beyond traditional analytics capabilities and significantly improve predictive functionality and overall ROI. With edge AI, software can proactively interface with live data streams and cater to intelligence at or near the source, leading to increased overall productivity, efficiency and cost-savings. ▣



CIP security in 2020

By Phil Marshall, Hilscher North America CEO

□ Security issues need to be top-of-mind for automation vendors, integrators and users. Fortunately, enabling technologies are available to help mitigate security concerns for our automation devices and networks.

One of these is CIP Security, which adds critical security features

to the EtherNet/IP communications protocol. And with IEC 62443 now a required factor in product design, CIP Security will become a byword throughout our industry.

ODVA and its members have developed CIP Security as an open standard to integrate cybersecurity mechanisms into EtherNet/

IP. The goal of CIP Security is to enable the CIP-connected device to protect itself from malicious communications. CIP Security goes beyond traditional defense-in-depth approach by providing inherent cybersecurity mechanisms to defend the automation networks themselves. □

Mobile ERP will go mainstream

By Tom Brennan, CMO at Rootstock Software

One technology that is clearly breaking through the hype and set to hit a stage of mass adoption in 2020 is mobile ERP.

Mobile ERP and business-intelligence applications were first touted as ideal applications for busy executives who wanted to see their P&Ls and sales figures while on the road. It then became practical for workflow activity, such as obtaining approvals on purchase orders and sales orders, but it still catered primarily to management.

Now, thanks to cloud ERP, we are seeing mobile ERP applications being offered to every worker in a company, from sale reps who need to view inventory availability while at a customer's site, to shop-floor workers who need to record the completion of a work order with just a touch on a smart phone. Thanks to modern cloud platforms, ERP has been democratized. It has no boundaries, and it does not discriminate. It is ready for mass adoption.

In fact, mobile apps are beginning to address one of the biggest issues facing manufacturers today: the skilled labor shortage. ERP has a notorious reputation for being complicated and hard to

use. The thought of putting a full ERP system in the hands of just any employee was not feasible in the past.

Today, we are seeing our customers deploy mobile ERP applications to employees of any skill level. In fact, the mobile form factor and its widespread familiarity allows manufacturers to deploy very simple, specific and self-guided applications that can be used by anyone with just their thumbs. When these new applications are combined with customized workflows, workers can be guided to accomplish very specific tasks in the most efficient way. It minimizes the training required and minimizes disruption in high-turnover positions.

Mobile ERP is not an overhyped technology looking for a problem to solve; it is already solving real industry problems.

One of the more recent business challenges we've seen mobile ERP tackle is the ability to bridge the gap between traditionally siloed departments, such as sales and operations. We have a customer that deployed mobile devices to shop-floor workers to view their work queues and to mark the completion of work-order tasks. Their mobile devices are

also equipped with an enterprise social-media application (Chatter) that allows salespeople to communicate with workers on the shop floor to check the status of customer orders. The shop-floor staff can take pictures of the item in process and relay it back to the salesperson via a community-based social-media stream, which in turn can be passed onto the customer.

This company has now extended this capability to be part of their normal work-order process; they push it directly to the customer. A picture of the completed item is tagged to the work order and automatically emailed to the customer just as it's ready to be shipped. This keeps customers involved and informed—it gets them excited that their order is on the way.

Who would have thought shop floor mobile apps could improve customer service and loyalty?

While there is plenty of hype around digital-transformation technologies, it is clear that mobile ERP is set to spawn many targeted and innovative use cases in 2020, to the point that the manufacturing industry may take up iPhone's once touted slogan: There's an app for that. ▣



MORE EXPERT PERSPECTIVE ON DIGITAL TRANSFORMATION IN 2020.

“IT and OT professionals will collaborate better because they are gaining more understanding of the roles of each team and what each team owns. Swim lanes will be defined, bringing clarity. This will roll over to company structure and budgeting to accelerate the increased collaboration.

Security at the edge of the network will become more defined, either through industry consortiums or end-user requirements. (We’ve seen that you can’t take the security technology you’re using in the data center and apply it to the edge.) And security requirements might vary by industry. For example, retail may have different needs than financial services or manufacturing.

OEM builders will build more intelligence into their machines in recognition of the shortage of well-qualified technical staff in the field. They are adding predictive-maintenance capabilities; they want fault-tolerance and increased autonomy. There is no longer a defined line between the machine and the data. They are now intertwined. Machines can communicate and share data, without requiring staff with technical training.”

— Jason Andersen, vice president of business line management at Stratus Technologies

“When digital transformation stalls, it’s rarely about the technology itself. It’s about readiness. It’s about enabling customers’ capabilities in using these tools. That is what we are focused on in 2020.”

— Pat Byrne, GE Digital CEO

“As we look ahead to 2020, water utilities across the nation are preparing for water supply issues. One of the ways utilities are preparing is with the use of cellular solutions. Cities are using cellular networks to achieve ‘smart water’ and become water resilient while replacing aging infrastructures.”

— John Fillinger, director of utility marketing at Badger Meter

“Robotic Process Automation (RPA) will become the de facto tool for democratizing artificial intelligence. RPA will act as the gateway to the types of AI services that are user-friendly to the average business man or woman—these services include sentiment analysis, text analytics, handwriting recognition, etc.

RPA will provide insights that prove integration’s business value: revenue gains, cost savings, elevated NPS, KPIs, etc. This will be particularly of interest to C-level executives.

Businesses will become most interested in faster and easier ways to implement and scale RPA.

AI living within your bot will use algorithms to identify, create, execute, monitor and fix any problems that arise in an end-to-end AI-style cycle.

And next year, RPA will start to fulfill the citizen-developer vision – where each business user is a force multiplier in the automation efforts of the organization. This will be made possible through real-time insights.

New solutions will come to market to promote and monitor multi-vendor RPA optimization and the creation and execution of tasks between vendors. In addition, this will create a more central location to monitor its impact on the overall organization.”

— Shay Antebi, CTO of Kryon

“LED manufacturers are focusing on improving quality-of-light by bridging the efficiency gaps between the Color Rendering Index and color temperatures. Balancing efficiency and color-rendering will enable luminaire manufacturers to design products with a higher quality of light while meeting demand for high-color rendering without sacrificing efficacy. LED manufacturers are also developing products with the full color spectrum to light up objects (as they would appear in sunlight for applications where visual acuity and color accuracy are critical.”

– Vishnu Shastry, lead optical engineer with Dialight

“One of the biggest trends we are seeing in our industry is a way to make operations primarily cloud-based, especially in manufacturing. When many factories were built, they were dependent upon manual data gathering and machine operation. In today’s world, many machines still operate by human hand, but the way to gather data and run a plant efficiently through automation has changed. Manufacturers are attempting to make their facilities cloud-based

and are running into complications. Machinery and, most often, the overall infrastructure of the building are not equipped with the right connections to make this possible. With MQTT and OPC UA protocols acting as the de-facto standards for cloud-based operations, we must find the proper gateway for them to gather information from the industrial fieldbus. It is our job to have engineers and product managers work with these businesses to find the right connections to facilitate the cloud-based applications that they are looking for. With the correct complement of interconnections, we can make wiring easier, connections stronger and processing faster.”

– Charlie Norz, product manager with WAGO-I/O-SYSTEM

“Technology is set to significantly disrupt the current warehouse and transportation industries and improve them through enhanced, end-to-end visibility and warehouse-modernization efforts that yield greater speed and effectiveness.

Challenges, such as customers demanding more timely deliveries, worker shortages due to difficulty in hiring and retention, as well as limited warehouse space, will lead to increased reliance on advanced solutions that improve operational efficiency in the supply chain. With an insufficient labor pool to meet growing demand, businesses will turn to technological solutions that can augment workers for new workflows, greater automation initiatives and the smart-tasking of workers. These new solutions rely on visibility, prescriptive analytics and mobility to overcome operational challenges.

In addition, in 2020 robots will assist (rather than replace) workers by guiding them through their workflows and transporting items and completed work, taking away inefficient travel time that can be used by workers for higher-value tasks. In this way, robotics solutions can take the robot out of the human and allow companies to reallocate their human labor force toward the greatest area of need and highest value. Cooperative orchestration between automation systems and human workers will be critical to achieving the highest levels of productivity improvement in the not-too-distant future.”

– Mark Wheeler, director of supply chain solutions with Zebra Technologies

“In 2020 we anticipate that general awareness of 3D-printing technology will continue to grow across all geographies and industries. Our recent research found that nearly 2/3 of businesses are unaware of the technology and how it can benefit their bottom line. If they are aware of it, they are not using it. This indicates huge potential growth for the technology across all sectors.

Our index also found 3D printing is being used by about 35% of business globally, showing that the technology is maturing from the hype stage and moving into a mature and established technology. There's no doubt this upward adoption trend will continue well into 2020 and beyond. However, a barrier to implementation of 3D printing into the enterprise workflow will be the growing skills gap and the need for education and training across management levels. Currently, the average age of the enterprise 3D printing user is 38-39 years old, with just 2-3 years' experience with the technology. A focus on training and education will be necessary to accelerate widespread adoption of 3D printing. In 2020 I expect companies to begin to place more emphasis on this."

– Rohit Jhamb, director of global research & analytics with Ultimaker

"2020 will be the year industrial companies come head-on with reconciling data and legacy systems. These organizations are facing an unpredictable marketplace, and massive volumes of operational data sits in various siloes. Combined with urgent requirements to digitize and a shortage of IT talent within the manufacturing realm, we will witness a greater demand for technologies that bridge "old" with "new" (legacy to digital) without requiring companies to rip out years of previous investments."

– Rin Nagaike, CTO, HULFT, Inc.

"Digitization is transforming the DNA of industrial manufacturing—the way we work, the skillsets needed and the way an organization is structured. If manufacturers haven't yet figured out that digitization is the key to gaining competitive advantage, their future is questionable and will fall behind the new breed of market-leading 'digital champions.' We're seeing that digitally smart manufacturers are exploiting emerging technologies and trends such as digital twinning, predictive maintenance, track-and-trace and modular design. To continue to maximize the benefits of becoming more digitalized, CEOs should consider making these four significant changes in 2020 and beyond:

- 1) Drive organizational changes that addresses new digital capabilities and digital processes**
- 2) Hire more software/IoT engineers and data scientists while training the wider workforce in digital skills**
- 3) Learn from software businesses that have the ability to develop use cases rapidly and turn them into software products**

4) Extend digitization beyond IT to include significant operational technologies.”

— Jeff Sorensen, PwC’s industrial products leader

“It can be difficult to predict new cybersecurity threats, but here are some predictions we believe will hold true in 2020:

SOPHISTICATED CYBER-FRAUD WILL INCREASE

We expect ransomware attacks to continue, however we also expect to see a rise in more sophisticated strategies such as deepfake executive fraud. Instead of attempting to extort companies, cyber-criminals are now infecting networks and watching for opportunities to steal financial information or leverage compromised email for fraud with bigger payouts.

TWO-FACTOR AUTHENTICATION (2FA) IS A MUST, BUT NOT A GUARANTEE

2FA has become the modern standard, but workarounds have already been discovered. Organizations will need to ensure they are using 2FA enhanced with one-time password (OTP) proxy detection, additional security challenges for logins from unrecognized IP addresses, and more robust suspicious-activity notification settings. Alternatively, they should leverage multi-factor authentication (MFA), which implements additional security checks.”

— Sébastien Boire-Lavigne, chief security officer with XMedius

“The convergence of IT and OT will continue. OT security has slowly gained recognition over the years as a necessary function within organizations, especially as operational technology is being exposed to cyber-risks at unprecedented levels. As such, it is finally being recognized as a core element in enterprise-risk management. But organizations may not have the dedicated resources needed to effectively manage the systems. Therefore, the roles of IT and OT security professionals are converging, meaning there is a need for more visibility, training and more clearly defined processes.

More people will hold the chief tech security officer role, replacing or re-naming the CISO. The role of the chief information security officer is on its way out. As with the evolving IT/OT landscape, the roles and responsibilities of those in charge of overseeing systems will, too, change. CISOs will become a thing of the past, yet CTSOs will become more commonplace. Technology plays such a large role in today’s organizations; companies should bring in a CTSO to oversee the tech that houses both the information and the security of all the systems in place (OT, IT, etc.).

There will be zero hours of electrical downtime as a result of a cyberattack. While the electric industry continues to be a target for both foreign and domestic cybercriminals, no customers will lose power at any time from a cyberattack. The “doom and gloom” outlook that many people have—the lights going off and no one being able to turn them on—is unfounded. There will be no ‘digital Pearl Harbor’ next year.”

— Dave Weinstein, CSO of Claroty

“Blindly sending all industrial data to the cloud has become the mantra for starting down the analytics or IIoT path. Data lakes are being filled with petabytes of industrial time-series data with a hope that AI and machine-learning-based analytics will make sense of it and provide valuable insight. This has increased the consumption of bandwidth and storage, but has done little to generate value for industrial companies.

In 2020, we predict a course-correction as manufacturers rethink their data architectures and increase intelligence at the edge. These early adopters will recognize the need for a more balanced cloud/edge strategy. They will create a new, on-premises abstraction layer that connects and models real-time operations data at its source. This will enable them to easily deliver edge intelligence to operations, while providing clean and contextualized information to users and consuming applications in other business functions. A focus on improving data infrastructure and increasing edge intelligence will be a game-changer in 2020 for industrial companies ready to get their IIoT projects out of pilot and into production.”

— Torey Penrod-Cambra, co-founder and CMO of HighByte

“In 2020 we can expect to see continued rapid growth of additive manufacturing for production applications. Companies are moving out of the exploratory phase and starting to adopt additive as a scalable manufacturing solution. This is because additive technologies and materials continue to get better, faster and cheaper, making this a viable option for many businesses. We should definitely expect to see businesses realizing the tangible benefits of additive in the coming year.”

— William King, co-founder and CEO of Fast Radius

“I think one thing we’ll be seeing in 2020 is engineers and integrators having more fun and really accelerating the progress they are able to make toward digital transformation. We now have so many technologies that can

work together—and it's really helping people build their dream solutions. I feel so many technologies have matured and come together that it is now possible to build out correct enterprise architectures that really allow industrial organizations to connect sensor to cloud or edge to enterprise in very productive ways. With things like unlimited licensing, open standards, interoperable systems and faster development, people are finding a great deal of satisfaction in their work these days. For example, system integrators get to say “yes” to their clients a lot more often now. It used to be “no, we can't do that,” because the tech wasn't there or the costs were prohibitive. It's a lot more fun when you can say “yes!” People have been very creative lately in putting together systems that weren't possible just a short time ago. So many people have told me that their work is fun again, and I expect that trend to increase as even more new tools become available in 2020.”

— Don Pearson, vice president of sales & marketing with Inductive Automation

“Industrial companies will continue to shift toward artificial intelligence-based solutions for analysis of cybersecurity data. This is part of a broader trend of companies shifting toward tools that can efficiently and effectively automate tasks, such as workforce challenges, costs, and security needs. AI and machine-learning tools will leverage data (the new oil in cybersecurity) to augment human decision making.

But industrial companies in particular are looking for ways to better protect their critical infrastructure devices, the vulnerability of which have become more apparent in the past years given the growing number and increasing severity of attacks on power utilities and manufacturing plants. CISOs are hungry for tools that can help them with this problem and AI has the potential to flag anomalous activity that could point to an attack and analyze sensor data for more effective response to security threats and even predictive maintenance needs. Both of these are important because downtime in critical infrastructure environments can be catastrophic. AI is far from a silver bullet, requires extensive expertise and is still largely in early technical innings, but demand for it will grow in 2020 and beyond.

In 2020, disruptionware will increasingly intersect with connected systems and rogue devices in building automation and other OT systems. These disruptionware attacks include ransomware, but also reach more broadly to include disk-wiping malware and similarly disruptive malicious code.

We expect to see many more of these attacks in 2020. We also believe there will be at least one big attack on a major energy or manufacturing company that will severely disrupt the company's operations. This event will serve as yet another

wake-up call to CISOs to reconsider the IT/OT convergence inside their own companies, evaluating technologies like network segmentation, which will allow them to protect these systems. It will also serve as a wakeup call to federal and state regulators, who will put more pressure on power, manufacturing and healthcare sectors with more robust regulation.”

— Rob McNutt, CTO with Forescout Technologies

“Because the supply chain industry has historically been slow to adopt when it comes to digitization, there simply hasn’t been enough collected data for artificial-intelligence and machine-learning algorithms to make reliable suggestions. As we start to see a more modern supply chain emerge in 2020, AI and ML algorithms will enable a 30,000-foot view of the supply chain and provide valuable insights to ease previously tedious processes like product redirects, new partner and supplier onboarding, order cancellations, oversupply and more.”

— Jorge Rodriguez, senior vice president of product development at Cleo

“The development of graphical user interfaces combined with quick access to data and images is driving much of the changes that are currently taking place in vision systems relating to manufacturing. This applies to all sectors, but it is particularly important in high-specification and highly regulated industries like pharmaceutical and medical-device manufacturing, where data archiving, traceability and warranty protection are key. I fully expect to see growing demand in this area across many sectors in 2020.”

— Earl Yardley, systems director with Industrial Vision

“In a manufacturing world filled with predictive analytics, machine-based learning, and the Internet of Things, one might predict that the future looks bright for women in US manufacturing jobs. After all, since the days of Rosie the Riveter, more women are becoming employed in jobs that were traditionally held by men. However, similar to what befalls artificial intelligence, what data can’t predict is sentiment and feeling about the future of career development and gender diversity within those jobs. Using data published in Influential Women in Manufacturing’s 2019 Gender Diversity and Career Development Special Report, we predict positive growth for gender diversity in US manufacturing; however, there’s a catch. Many companies still need to catch up with the career development needs of all genders of their workforce.”

— Erin Hallstrom, the creator and co-founder of Influential Women in Manufacturing

“Artificial intelligence and machine learning were the buzzwords of the year in 2019, but I didn’t see many companies able to fully monetize those initiatives. We’re seeing through our ecosystem of IoT leaders that industry end-users are looking to engage multiple partners to solve their business problems through enabling technologies like artificial intelligence, machine learning, digital twins, 3D printing and augmented reality. Beyond the hype, we will see more monetization in that space and more innovative solutions that help drive business in 2020.”

— Dr. Richard Soley, the executive director of the Industrial Internet Consortium

“Looking ahead at 2020, enterprises who have successfully implemented the IIoT have and will be ones that put their workforce as the focal point of their digital-transformation strategy. In 2020, we predict this strategy will come full circle, as companies will be pressed to demonstrate what the impact of their implementation has been—what benefits have they, their industry, or the public realized since they transformed. Faced with shifting customer expectations, uncertain global trade and cost pressures, and workforce shortages, companies

will be pressed even more to show how their product and service offerings, operations, and workforce development have had a positive impact on the ecosystem around them. Notably, with these clear business challenges coupled with the equally clear value proposition for applying IoT and AR solutions, we predict a marked increase in the number of such implementations, increased programmatic focus on delivery of value, and consequently more aggressive implementation timelines.

We anticipate the next year will see the technology's impact and value expanded upon with the integration of AI into the fabric of solutions, rather than the tools-and-techniques approach of the past, and the continued convergence of IT and OT. Additionally, while mainstream deployments are likely several years away, we do see 5G already impacting architectural and infrastructure planning within large enterprises, and those planning activities are already manifesting as forward-looking views on the role of the cloud, the intelligent edge, and the next-generation networks. We view this as the next phase of implementation, with the first portion being a customer's selection of IIoT. We also expect the industry to reach a tipping point in embracing the SaaS business model. Utilizing 5G, the IIoT will be powered by enhanced connectivity capabilities and able to process data at faster speeds, reducing downtime for organizations. With access to AI, companies will be able to assess the data and receive recommendations at similarly quickened rates, enabling OE achievement at a pace not previously realized."

— Joe Biron, CTO of IoT at PTC

"Electric vehicles (EVs) are set to make up more than half of global passenger-car sales by 2040, and poised to increase strain on the distribution grid. Meanwhile, renewable energy continues to gain momentum, driven by mandates and environmentally conscious consumers challenging utilities to ensure grid reliability. Amid these challenges, utilities will have to balance grid optimization and load control. Utilities will look to leverage unique data streams to determine more short-term forecasting mechanisms. For example, knowing where cloud coverage is across a certain region will enable utilities to predict how that coverage will impact solar capacity. By combining sensor data and weather forecasts, utilities can perform short-term forecasting of how distributed generation is impacted by weather so that they can bring other resources online to replace the solar-electricity generation impacted by cloud cover."

— Jeff McCracken, director of operations management outcomes at Itron

