Manufacturer’s Guide: IoT, Sensors, & Predictive Analytics
How is the IoT changing enterprise service management?

Laura Aberle

Manufacturers are starting to use IoT-enabled devices to monitor equipment performance and improve field service, but the full benefits of IoT for enterprise service management have yet to be seen.

BOSTON -- As companies begin to use the Internet of Things (IoT) to keep tabs on equipment performance and remotely diagnose problems, the resulting flood
of sensor data presents opportunities to spot trends and predict failures. According to experts, field service engineers and call center agents could shift from providing reactive service to playing a proactive role in equipment maintenance and even product development. But first, organizations need to establish the necessary IoT technology and processes.

In a panel at the recent IFS World Conference 2015, Adam Brody, director of enterprise systems at Sysmex America, Inc., and management consultant Michael Blumberg of the Blumberg Advisory Group, Inc., discussed the IoT’s applications for enterprise service management today and in the future.

According to Brody, Sysmex, which uses IoT technology to perform remote performance monitoring and diagnostics on its medical equipment, didn’t jump on the IoT trend because of the hype. The company's customers in the medical industry helped drive the change.

"There was a time when businesses were driving the consumer world. Now it's the opposite. You have the consumer using mobiles devices and Internet of Things [technology], and they're saying, 'Bring that into the business,'" Brody said. He added that medical device technicians are a dying breed for the customers Sysmex serves, so there’s typically no one in-house to perform the necessary diagnostics. "Our customers were demanding that..."
we find a way to get this information because they have a lack of resources within the laboratory."

As customer expectations and requirements change across industries, "I can't think of an industry that won't be affected by IoT," said Blumberg, who specializes in reverse logistics and the service supply chain. "With any technology that requires service, as long as there's a way to connect a sensor, there's an opportunity for IoT."

### IoT-enabled service requires big data strategy

Companies that want to use IoT technology to transform service management face some major obstacles, including updates to technology infrastructure. "Some technology out there is 10 years old. If you really want to adopt IoT throughout the enterprise, every piece of technology has to be IoT-enabled. That's going to take some time," Blumberg said.

But IoT for enterprise service management requires much more than installing sensors on equipment. A company like Sysmex that has implemented IoT technology must now grapple with big data. "Our organization had to figure out; we have all of this information, what are we going to do with it?" Brody said.

He advised developing a strategy as early as possible, not just to glean useful information from the influx of data, but to avoid the potential pitfalls of gathering
customer information. "Especially being in the healthcare market, now you're opening yourself up to HIPAA (Health Insurance Portability and Accountability Act) compliance. Without planning ahead, we would have been up the creek to some extent," he said.

Then there's the issue of turning sensor data into actionable information.

"We have connected devices flooding our servers with information," Brody said. "It's trying to pick it apart and grasp the right information from those devices. We have that information interconnect with some of our back-office applications, whether it's our ERP or our field service management or even our sales force management tools. It's making that information go to the right places, analyze it and get the right data from inside that massive amount of information."

Solving equipment problems before they occur

Field service and call center operations are traditionally reactive: An immediate problem comes in and a call center agent or field technician tries to resolve it as efficiently as possible. Blumberg said that IoT-enabled devices have the potential to transform enterprise service management into a proactive practice by helping organizations predict problems and head them off. "If you can see something’s happening and get someone to resolve it before a problem occurs, there's value in that," he said.
Service driven by predictive analytics could change not only the role of the field service engineer, but call center agents as well. "Call center people will become more like data scientists, having to track and analyze data and predict what might happen, as opposed to just taking the call as it's occurring," Blumberg said.

Blumberg also mentioned IoT's potential influence on product development. "As we move toward the 'servitization' trend where you only get paid if your equipment is working, all that knowledge that the field service engineer is collecting will help design a better product that will operate at a higher level of reliability," he said.

But for Brody, IoT's immediate value is that remotely tracking equipment performance encourages a certain standard of service. "I think it's raising the bar, at least within our organization," he said. "We have hundreds of field service technicians across the country, both high-experience techs and newbies. With the Internet of Things, we're starting to see that people are becoming more consistent and our service is going to get more standardized and consistent because of that."

Next article
Internet of Things use cases show progress

Donna Fluss and Scott Sachs

It may be early in the game, but use cases demonstrate that Internet of Things pioneers are having great success with IoT-connected products.

With all the hype surrounding the Internet of Things (IoT), you might expect that smart refrigerators automatically placing orders to replenish groceries or cars self-repairing faulty parts would be commonplace by now. Although the industry is heading that direction, manufacturers are only beginning to integrate IoT capabilities into existing offerings and design new products and services that will wholly transform business models.

At the LiveWorx 2015 IoT event held earlier this month in Boston, PTCexecutives, IoT technology providers and companies pioneering IoT-related products and services made the case that IoT is not some promise of the future, but rather workable technology already having an effect on products today. That is true, but most of the Internet of Things use cases presented by pioneers are test case scenarios and limited production products, more in keeping with demonstrating IoT’s potential than serving as mainstream products.
Internet of Things pioneers lead the way

"It's still very early on -- we are just beginning to see a lot of real solutions in the marketplace," said Chris Penrose, senior vice president, Internet of Things, for AT&T Mobility. "We are no longer having conversations about the value of putting connectivity in products -- everyone sees that. We are now getting in the use case, and with 22 million devices on a network that aren't phones or tablets, it's a market that's growing at an incredibly rapid pace."

Michael Porter, Bishop William Lawrence University professor at Harvard Business School, outlined four functionality changes manufacturers experience as they embrace the concept of smart, connected products. Initially, connectivity delivers the ability to monitor and measure what's happening to a product in a very granular way, providing the basis for a range of use cases, including remote diagnostics and fix services -- the focus of many Internet of Things pioneers. Connectivity also can provide a path for separating control of the product from the physical product itself, essential for remote control applications, he explained.

As the basis for building new, related services and optimizing utilization, Porter said, manufacturers can collect and analyze data from a product. Once manufacturers are monitoring everything about a product and its environment,
he said the next step is autonomy, driven by machine learning, which allows a product to determine what to do next without human intervention.

Internet of Things use cases from pioneering companies

Although it's still early days, pioneers are making headway with offerings that span a range of industries and a variety of Internet of Things use cases. Here are four examples already in the works:

Airbus' factory of the future: The multibillion-dollar aircraft manufacturer has big plans to leverage IoT to transform its commercial airline fleet, but it also believes the technology will play an essential role in streamlining manufacturing. Unlike other industries that fully automate production processes, humans still play a primary role in manufacturing and assembling aircraft.

The margin for error is slim. Any single mistake in the process, which involves tens of thousands of steps, can be costly. At a LiveWorx session, Jean-Bernard Hentz, head of PLM R&T and innovation at Airbus ICT, described a vision the company calls Rosie the Riveter 2.0. As part of this vision, Airbus is developing smart tools and other shop floor systems that create a system of record to ensure operators don't make mistakes by managing and checking on tasks as they are in process. Using smart glasses or tablets, workers can scan an
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aircraft’s frame to determine everything from what size bolt is needed to how much torque is required for proper installation.

**All Traffic Solutions’ smart signs**: To stand out in the crowd of commodity traffic sign hardware manufacturers, All Traffic Solutions made an early bet on a connected strategy, integrating sensors and a cloud-based IoT platform directly into its products. The signs, now used in a variety of cities around the world, are sold with a range of subscription services, including those for remote equipment management, remote diagnostics and road notification messaging.

Evolving the technology piece of an IoT strategy is the easy part, according to Ted Graef, president and co-founder of All Traffic Solutions. "The connection is really the beginning," he said. "You have to figure out what to do with the connection and how to make money off of it and that takes the whole company."

**Yankee Candle scent systems**: Yankee Candle is leveraging IoT to break out of its mold as a traditional manufacturer of homespun candles. The company is building a new business called "intelligent scent," designed for retailers to incorporate scent into their overall brand impression. Smart scent fixtures, to be released soon, will be connected via the Web to an integrated global network, which then can be controlled by a retailer using a mobile device or Yankee Candle's own command system. The remote control capabilities are used to monitor and fine-tune scent concentration across multiple locations so that -- without requiring employee intervention -- a scent never runs out.
StreetScooter's smart delivery vehicle: Designed from scratch as an optimized electric vehicle, StreetScooter also is unique in that it leverages IoT technology to help reduce engineering complexity. Given a mandate to design and test the vehicle with minimum resources and in a short time period, IoT technology helped streamline engineering processes, according to CEO Peter Burggräf. Project engineers get constant feedback from the car on everything from performance to its state of charge. By comparing real-time data to preliminary requirements, the team has been able to more easily validate designs and avoid over-engineering.
Smart sensors are changing the world for manufacturers

David Turbide

A proliferation of inexpensive and smart sensors is enabling a new age of visibility inside manufacturing plants and throughout the supply chain.

The most visible and obvious elements of the Internet of Things (IoT) and its industrial version, the IIoT, are smart sensors -- the devices of every imaginable description that come with the ability to connect to the Internet and exchange information. It is these smart sensors and their data streams that give rise to big data (along with video, text and social media) and the associated challenges to traditional IT systems. There is so much data, and such a variety of data, that new software and systems are required to deal with it.

The supply chain is mostly about inventory and transportation -- goods in transit or in storage. The two primary dimensions of supply chain big data, then, are what and where. What items in what quantities are being tracked, and where are they at the present moment? Depending on the specificity of the identification, individual items might be tracked or the identification may be limited to certain quantities (case, pallet, container load) of an item. Additional
information pertaining to the item or quantity can be linked to its identity (lot number, date of manufacture, quality measurements). Similarly, location-specific data also can be captured, including parameters such as temperature and humidity.

Supply chain sensors fall into three categories

Sensors for supply chain tracking fall into three general categories: identification, location and environmental. The state of the art in identification is radio frequency identification (RFID) tags that can be placed in or on items, cases, pallets or containers that self-identify when passing through a reader’s electronic field. Although RFID is gaining traction in the supply chain, the majority of auto ID is still done with bar codes, an established technology that is inexpensive, highly reliable and relatively simple to implement and use.

Identifying the items also establishes the location, for scanners or readers with fixed locations, as in a plant or warehouse. Once the goods are on the move, tracking the vehicle (with its known contents) relies on location-aware technologies, primarily global positioning system (GPS) receivers. These devices, once they have established their own location, can upload the location data through the Internet where it is matched to the identity of the vehicle or container contents. Supply chain tracking devices often combine the "what" and the "where" whether through its fixed location or GPS.
Picture a case of product, pulled from warehouse inventory (bar code scan) and placed on a pallet with other items, then shrink-wrapped together. The pallet has a bar code "license plate" which, when scanned, relates the contents to the pallet ID. An RFID tag is also attached to the pallet. When the pallet is moved into the waiting trailer, the RFID reader adds the pallet and its contents to the truckload manifest. On the road, the truck's GPS sensor records the load's movement to its destination. The pallet's RFID tag tracks the pallet's movement into a warehouse.

GE plant a poster child for use of smart sensors

Some goods and shipments must be monitored for handling and environmental conditions -- foods and some pharmaceuticals must be kept within a certain temperature range, for example, and some shipments of delicate articles might be monitored for rough handling. For these purposes, connected sensors of many types and capabilities are now available. Some companies are even using consumer devices like webcams as inexpensive and readily available connected sensors to supplement monitoring throughout the supply chain.

Environmental measurement sensors are particularly useful inside the plant and warehouse to keep an eye on conditions, log the data for historical record and quality management, and as triggers for alarms and process management.
The poster child for this new Industrial Internet of Things is GE’s new (2012) $170 million battery plant in Schenectady, New York. The factory, making advanced sodium-nickel batteries, has more than 10,000 smart sensors monitoring things like which batches of powder are being used to form the ceramics at the heart of the batteries, how high a temperature is being used to bake them, how much energy is required to make each battery, and even the local air pressure. On the plant floor, employees with iPads can pull up all the data from Wi-Fi nodes set up around the factory.

Smart sensors enable new age of plant visibility

Temperature and humidity can affect batteries, so the factory has more than 100 air pressure, humidity and temperature sensors. The system monitors inside and outside conditions and controls air conditioning and ventilation vents to maintain optimum conditions for high product quality and yield. Every part is tracked with serial numbers and bar codes. Managers can easily see how much energy it took to make a specific battery part, for example, or study a day’s production with full data on all conditions, equipment used, operator identification and more.

This proliferation of relatively inexpensive and very smart sensors and devices is enabling a new age of visibility inside the plant and throughout the supply chain. As technologies and applications evolve to be able to exploit this windfall...
of big data, companies will have the means to more closely control inventory, delivery lead times and product quality to a level never before possible. Contact centers provide an opportunity to report everything that can be measured, and there are various ways for the metrics to be presented: as data points, information or analytics. The key challenge is to understand the value -- and the limitations -- of these metrics and to ensure that a proper dose of art complements the science.
Predictive analytics in manufacturing starts to take hold

Scott Sachs, SJS Solutions

Manufacturers are realizing that long-term sustainability requires the ability to exploit machine-learning algorithms by employing predictive analytics.

Manufacturing, the colossal old guard of the economy, is inching more clearly into the future of expanded automation.

Ultimately, manufacturing and its entire supply chain will reach near-total automation, a paradigm shift as dramatic as that represented by the Internet, experts said. Manufacturing is emerging from a brick and mortar mentality, realizing that long-term sustainability pivots on the ability to exploit machine-learning algorithms by employing predictive analytics.

The simplest and most general application of predictive analytics in manufacturing is preventive maintenance, which anticipates equipment deterioration. Replacing moribund parts before failure prevents unexpected and costly stoppages.
Armed with sensor data, predictive analytics can also inform a manufacturer about ways to more advantageously place equipment and personnel, run assembly lines more smoothly, manage inventory more efficiently and streamline process controls. Superior deployment of resources cut costs.

**Bulk of manufacturing in early stages of adopting predictive analytics**

Although industries such as finance and insurance are frequently fully analytics-automated, the bulk of manufacturing is wading in the emerging stage of adoption. "Across the manufacturing clients we work with -- no higher than 20% would be called an analytics competitor," Jack Phillips, CEO and co-founder of the International Institute for Analytics, said. "In manufacturing there is still a prominent culture of making decisions based on experience and guts."

Manufacturers continue to rely heavily on charts and spreadsheets. "Even in 2015 we’re finding that very large, multinational corporations still have manual processes such as Excel and pie charts to make forecasts," Mike Hitmar, product marketing manager, manufacturing & supply chain at SAS, said.

Still, the pockets of manufacturing that do embrace predictive analytics are setting a strong tone, largely due to the prevailing power of what's commonly called the Internet of Things (IoT) -- the interconnecting of a web of devices that send data to frameworks in real time.
Predictive analytics in manufacturing evolves from buzz to action

With flawless predictive analytics and without limitations of storage, connectivity and computing power, all machines, theoretically, could automatically act on analysis of constant streams of data. In other words, the interconnected machines would self-correct, hyper-accelerating innovation to the tune of casting forth the next industrial revolution.

German automaker BMW is moving in that direction by outfitting test cars with thousands of sensors that send data to the factory whereupon predictive analytics -- supplied by IBM -- offers adjustments that can be made manifest as soon as the next manufacturing stage. IBM business analytics director Erick Brethenoux said that overall technical improvements in recent years have combined to create a far superior product at a lower production cost. "The sensors are smaller, more durable, more capable, more precise," he said. "Also, computing power is stronger and faster because of the ability to parallelize in frameworks like Hadoop."

Ingo Mierswa, CEO and founder of open source platform Rapid Miner cited a current customer (a major European concrete manufacturer) that is using predictive analytics to bolster throughput that recently increased from 70% to 95%. What's more noteworthy, however, is the trajectory of automation. "In 6 to
Manufacturers are increasingly valuing visibility into an entire operational process in real time. Bryan Tantzen, senior director for IoT at Cisco, said at the World Forum of the Internet of Things in November 2013 that manufacturers sensed the buzz swirling around the IoT but at the same conference a year later -- October 2014 -- the buzz evolved into action. "Six months ago all the major manufacturers I met had initiatives underway to pilot and deploy the Internet of Things capabilities in their plants to drive predictive analytics," he said.

Real-time analysis of big data enables newfound possibilities

The learning curve can be substantial. Converging siloed networks, unifying machines and adopting more flexible compute models represent tall tasks. And although the cloud is the definition of efficiency, it comes with security concerns that have not been thrashed out. Also, manufacturers must decide between spearheading proprietary solutions or opt for the open source route. Proprietary solutions dominate the market and offer valuable services. But the open source way is less expensive and more flexible.

Rapid Miner's Mierswa said the chief advantage of such flexibility is the ability to gain access to the "black box," or the set of algorithms. "It's very important to be
able to change the algorithms because every manufacturer has unique ways of doing things," he said. "Perfectly matching algorithms to the needs of a company can create the best potential for success."

Yet the power of real-time analysis of big data is enabling newfound possibilities. Several years ago John Deere realized that the sensors on its tractors and machinery provided data so valuable that it could be leveraged to layer another business model. The sensor data not only informed predictive analytics on optimal ways to operate equipment, it also furnished data on soil and crop conditions and could be used to guide improved planting and harvesting strategies.

General Electric CEO Jeff Immelt has publicly announced that GE is investing heavily in the data gathering and analytical business to provide another service to its customers.

Pratt & Whitney also echoes this trend as it leverages maximum value from the plethora of sensors attached to nearly every machine and device. The sensors' data feeds into predictive analytic models that identify anomalies not otherwise observed. The result is information that yields accurate forecasts on optimal maintenance of aircraft and other equipment.
Providing outcome-based services becoming common

Phillips said the direction of John Deere, GE and Pratt & Whitney will soon attract many followers. "Providing outcome-based services is becoming the common playbook among the 20% of manufacturers that understand the value of data and analytics," he said.

Bill Jacobs, director of product marketing at Revolution Analytics, which supports the open source "R" language, said the integrated supply chains in the automobile, shipping and oil industries are showing the future for manufacturing across the board. "I think the Internet of Things in manufacturing will be ubiquitous in just a few years," he said. "The realities of the supply chain will demand it."

As Forrester analyst Michele Goetz put it: "The holy grail of predictive analytics in manufacturing is the "just in time" supply chain." However, the future of fully automated manufacturing operations and virtually instantaneous processes across the supply chain comes with side baggage. The movement of oceans of real-time data raises a bevy of legal issues. U.S. laws governing the movement of data comprise a disparate collection of state and federal regulations.

In Europe, data movement laws are more regulated. And already Germany has enforced a regulation that inhibits the full potential of the speed of data. IBM, for
example, recently facilitated a plan to more efficiently draw energy from the grid by collecting sensor data from appliances used by the German population. The plan was to recommend better times to use electricity to curtail costs and consumption. But the public bridled at the idea of the government knowing too much about their home activities. "We have the ability to mine data in people's homes in Germany every millisecond," IBM's Brethenoux said. "But the law says that we can mine this data only every 15 minutes. This is not bad because the public needs to be protected."
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