Better, faster stronger:

Smart manufacturing gains momentum

Smart manufacturing—also variously called the smart factory, Industry 4.0, the Fourth Industrial Revolution and other trendy names—is a concept, or perhaps a vision of an industrial paradise.

By Mark Watson

Initially introduced by the German government at the start of the decade, its defining characteristics include total factory automation, wireless networking, massive quantities of data, and connected as well as intelligent sensors working in harmonious concert with other devices. These devices can operate in groups, incorporating systems that can decide the importance of data and choose whether or not to forward certain pieces of information to humans.

It's a progressive, forward-thinking concept perfect for the unfolding millennium—of multiple manufacturing companies and their suppliers, customers and partners, all linked together via leading-edge industrial protocols and networking, able to make astute decisions and adapt to rapidly changing conditions in factories as diverse events occur.

The potential for smart manufacturing is huge, particularly when seen in the context of the global industrial automation trade. In 2013 the worldwide market for motors, generators, controllers and other industrial automation gear reached a gargantuan $169.4 billion, and is forecast to climb to $178.8 billion this year. IHS expects revenue to reach $209.8 billion in 2018.

Technology doesn't drive smart manufacturing

When discussing smart manufacturing, technology is usually the focus—sensors, networks, software, analytics. However, technology rarely propels major paradigm shifts, especially in conservative industries such as manufacturing. The true drivers of change are the factors necessary for corporate survival and success.

The prime imperative for smart manufacturing is the industrial sector's dire need for a skilled workforce. The current expert workforce of baby boomers, which manufacturers have depended on since the late 1960s, is disappearing, and the combination of an aging workforce of skilled engineers along with low rates of replacement is posing a significant concern for manufacturers.

The silver lining in the vanishing workforce is that smart manufacturing may perform more efficiently than the disappearing laborers ever did. While efforts in the past have been made to streamline traditional manufacturing and eliminate inefficiencies, such initiatives usually failed because major organizational change is difficult to undertake and even harder to maintain.

But even if humans resist and fear change, machines don't care—and an automated workforce may well be the most efficient and productive the world has ever seen. And one way to address the troubling problem of production inefficiency is to increase the levels of automation and semi-autonomous robots in manufacturing, ultimately driving the transition to the automatic factory.

Factories get smart

Smart manufacturing describes the new era of the intelligent factory, in which formerly separate manufacturing processes link together to produce intelligent data. In this model, standalone plants can also communicate with other factory sites, merging vast industrial infrastructures already in place with cloud computing and the Internet of Things (IoT). The end result is a complex, but vibrant, ecosystem of self-regulating machines and sites, able to customize output, allocate resources optimally and offer a seamless interface between the physical and virtual worlds of construction, assembly and production.

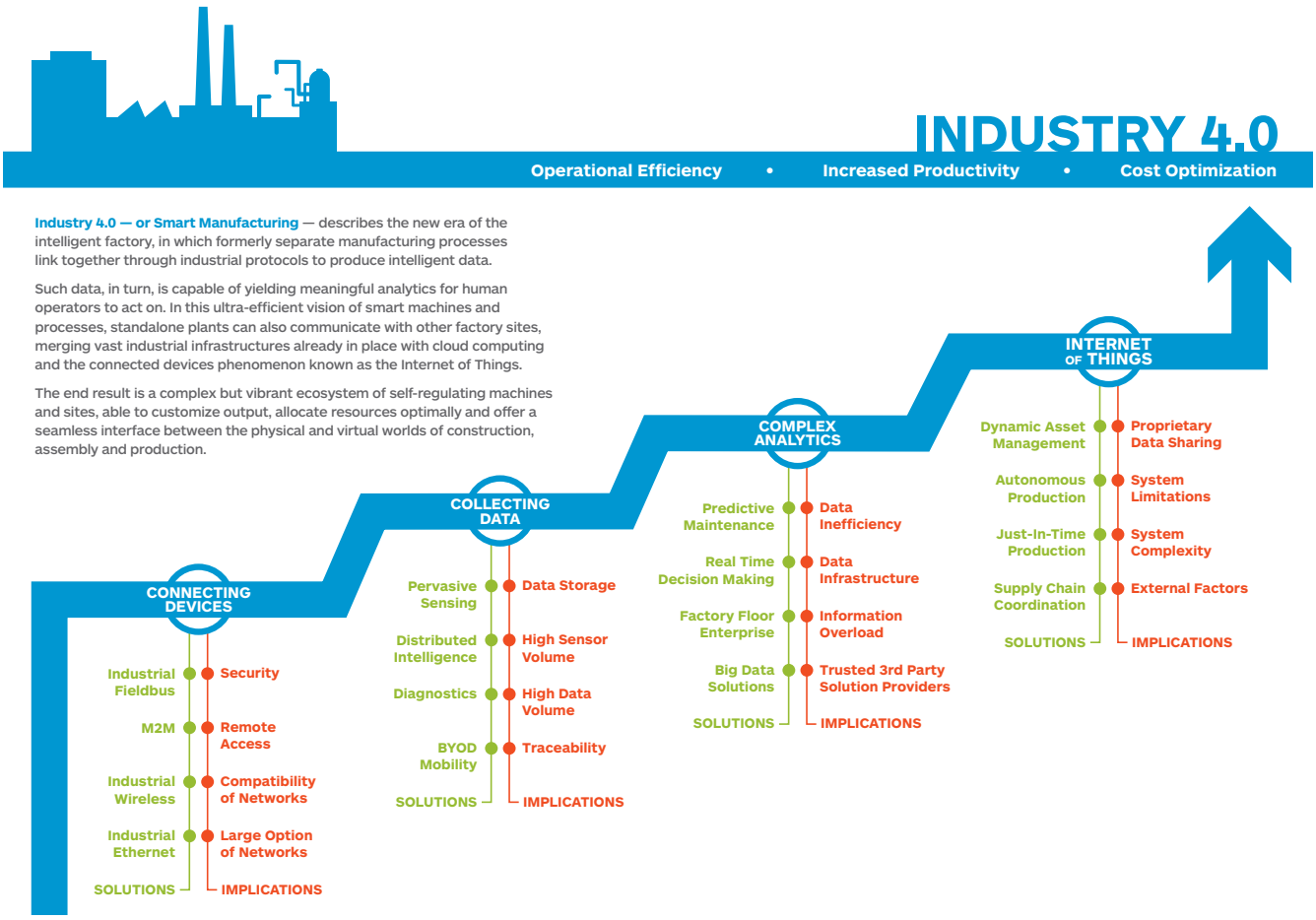
Taiwanese electronics contract manufacturer Foxconn exemplifies this flexibility and adaptability. The company produces 1 million iPhones for Apple per day, but Apple makes frequent changes to electronic components in the iPhone line, taxing Foxconn's capability to adjust.

To increase agility and meet Apple's demand, Foxconn is adapting its manufacturing lines and processes, making extensive use of computer numerical control (CNC) machines that perform automated management of machine tools. And even though Foxconn does not yet employ smart manufacturing, its adaptations for Apple represent important initial strides. Many other companies, like Foxconn, are also taking their first steps.

Enter: intelligent sensors

Sensors and controllers comprise the first line of smart manufacturing technologies, and they can be found among the machines on the factory floor.

Smart sensors are highly capable. They can gauge a tank of liquid, including its temperature, pressure and viscosity. Smart sensors can also detect and report low inventory to the company's enterprise resource planning (ERP) or to a human decision-maker, resulting in a refill order. A sensor might report a delivery van's breakdown, rolling out a second van to transfer supplies and a tow truck to rescue the disabled van. Overall, industrial settings can use sensors, data and connectivity to interact and make better business decisions.



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Along with sensors, controllers of various kinds—logic, sequence, motion and process—manage manufacturing processes and states such as maintenance, motions and machine sequences. For instance, controllers can securely lock down a 50-ton press when human workers are nearby, and sensors can verify the machine's safety.

Networks connect everything, but wireless makes inroads

Networking is the key enabler for smart manufacturing, but wired technologies at present rule on the factory floor over wireless. Fieldbus and industrial Ethernet are the two principal wired networking technologies, with fieldbus still dominant but industrial Ethernet slowly gaining ascendance.

In particular, initial doubts about industrial Ethernet's reliability, perceived inability to handle real-time data and other concerns have now been addressed, as evidenced by IHS projections of its market growth. The number of industrial Ethernet nodes will grow at an overall five-year compound annual rate of 11 percent from 2012 to 2017, compared to just 6 percent for fieldbus.

The rising need for more networked devices has boosted industrial Ethernet's acceptance. For example, new programmable logic controllers—essential in any factory—now feature multiple connections in one device, resulting in increasing counts of both ports and nodes.

Aside from wired protocols, wireless is now also deployed on the factory floor. Thanks to recent technology advancements, some new wireless sensors can operate at very low power for long periods, and wireless go-anywhere sensors can function where older sensors or technologies can't, such as in pipelines as well as near potentially deadly furnaces or spinning turbines of power plants.

A rising trend in factory floors associated with wireless is the

bring-your-own-device (BYOD) phenomenon, in which factory employees use their own smartphones and tablets to monitor and control industrial equipment. The smartphones and tablets in BYOD can allow users to manage equipment remotely, observing processes while employees are on the move or while they work in another part of the factory.

Overall, however, wireless at present remains a very small proportion of networked industrial automation devices. Wireless adoption will increase over time, but it is likely to be limited initially to specific applications—for long distances, moving components and inaccessible locations, among other use cases.

Data analytics brings it all together

Between 2014 and 2020, IHS forecasts digital data worldwide will grow from six zettabytes—or six trillion gigabytes—to an even more astounding 35 zettabytes, a phenomenal 483 percent jump. That's "Big Data."

As manufacturers go smart, they will face their own version of Big Data, with increasingly more devices being connected and the amount of information ramping up very quickly. A challenge for the Fourth Industrial Revolution, therefore, will be the development of software and analytical systems that turn the deluge of data produced by intelligent factories into useful and valuable information.

The industry has nearly zero expertise or analytic and modeling tools for managing and interpreting such volumes of data. Thus, buying or developing both tools and expertise will be priorities.

Fortunately, two elements of smart manufacturing—distributed intelligent systems and pervasive sensing—could help. The first involves making factory equipment intelligent and autonomous enough to independently determine which pieces of information are valuable and report that data to decision makers in the organization. Meanwhile, with pervasive sensing, intelligent sensors act together to make sense of constantly churning data. Such sensors, in turn, can link to the network through the all-things-connected Internet of Things. Via IoT, IP addresses can be assigned to each sensor and all other devices, enabling data to be traced back to their source.

IoT is the destination for all captured data. It will use the data to hasten the manufacture of new products. It will also employ the data to dynamically respond to product demands and to optimize real-time factory production and supply-chain networks. All these capabilities will be possible by connecting the smart factory's machinery, sensors and control systems.

The Fourth Industrial Revolution is coming

Smart manufacturing's development has barely begun. Industrial manufacturing not only lags other fields in connectivity and automation, it also has substantial established assets that are hard to replace quickly, including older embedded networks, stand-alone sensors and dumb equipment—as opposed to smart machinery.

And yet change is happening, even if the development of smart manufacturing will be evolutionary, not revolutionary—at least until some critical mass is reached.

One big challenge is cybersecurity. Because manufacturing has little experience with cyberattacks, many installations are vulnerable. To forestall hackers' assaults, manufacturers are adopting cybersecurity measures to manage greater levels of networking while controlling access and securing data. A new security standard, IEC 62443, which specifically addresses industrial security weaknesses, should help address the threat, with implementation expected to take off in 2015.

In the meantime, the benefits of networked devices and intelligent systems that can make decisions in real time will become increasingly obvious, and demands for more choices by customers will crescendo. The next 10 to 15 years will see an extraordinary paradigm shift, as manufacturing leaves the old production legacies of the 20th century behind and fully enters the smartly automated 21st.

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