Industry 4.0 Solves Major Manufacturing Challenges for China and the World

The key IoT opportunities for China include: first, a faster transition from “Made in China” to “Innovated in China;” second, an optimization of industrial structure; and third, a leap to the next level of intelligent IT.

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As the world’s top manufacturing country, China now faces challenges such as increasing labor and resource costs, a production paradigm moving from economies of scale to customization, and increasing competition from re-industrialization in developed countries. As the world’s leading business software service provider, SAP believes that insights from the sensors, data, and analytics associated with the Internet of Things (IoT) can help optimize China’s industry structure and accelerate vital upgrades. Clearly, these same IoT insights apply to any other country.

IoT for industry is sometimes referred to as the “Industrial Internet” or “Industry 4.0.” Whatever the name, this article describes the IoT’s key opportunities for China based on three typical applications and introduces a new IoT application. Also explained is SAP’s IoT vision based on the SAP HANA cloud platform, covering the IoT technology stack.

The key IoT opportunities for China include:

• A faster transition from “Made in China” to “Innovated in China.”
• An optimization of industrial structure.
• A leap to the next level of intelligent IT.

What’s Really New in IoT?

Sensors and Machine to Machine (M2M) communication have been around for many years, but they have improved dramatically:

• Sensors are getting better and cheaper, and they are omnipresent in any kind of new equipment on the shop floor. In the past, automated data collection was the exception; now it is getting to be the rule.
• Communication speed has increased so that data flows between devices and systems in near real time.
• Today’s standard protocols, such as OPC UA, make connectivity cheaper and more reliable.
• Cloud technology in combination with mobile devices provides visibility of information any place and any time, even among partners in a network.

These improvements enable a high degree of connectivity between devices on the shop floor as well as a much higher volume of collected data than ever before. For better manufacturing, the key is to take full advantage of this IoT data.

● Smart, Flexible Production with Small Lot Sizes at Low Cost

One use of IoT data is to enable the mass production of individualized products. At the beginning of a manufacturing process, each product has a unique identifier that allows an oversight system to control how that product is made.

The unique identifier is often stored on an RFID chip on the product’s carrier. At every work station the product passes through, the oversight system tells the machine what to do, whether the right tooling is installed, and whether the right components are in place. The system can check whether a production step was successful by comparing the results of an inspection step with the defined tolerances.

This type of production setup allows for small lot sizes, all the way down to a lot size of one, at low cost.

● Smart Analytics and Real-time Analytics

IoT data also enables smart analytics for optimizing manufacturing processes. The data can show what combination of process parameters leads to good yields and good quality. The data can also reveal the production issues with the highest impact. For example, manufacturers can identify the tool failures that have had the highest cost or have led to the most severe delivery delays. These smart analytics become possible by adding:

• Context or business information to the measurements from the shop floor.
• An understanding of the technical and business processes.

• A database such as SAP HANA that can manage a huge amount of data with finely tuned mathematical and statistical algorithms in an adequate timeframe.

One application of these elements is predictive diagnostics, including predictive maintenance or predictive quality. Based on historical data, manufacturers can identify measurement combinations that are indicators for machine breakdowns or quality issues. With this knowledge, it is possible to predict in real time when that situation is occurring again, thus allowing corrective actions before the breakdown or quality issue actually happens once more.

According to a recent research (ConMoto, “Wertorientierte Instandhaltung,” year 2011), maintenance costs in Europe in 2010 were EUR 450 billion (USD 616 billion). Where EUR 70 billion was the loss ascribed to ineffective maintenance and 300 billion was addressable by improvement. Traditional maintenance depends on expert knowledge and is usually rule or threshold based. However, this solution suffers from inaccuracy and difficulties adapting to changes.

Industry 4.0 promises better results when more than 50 billion devices are connected and zettabytes of data are being generated. Predictive maintenance utilizes this data with advanced machine learning to identify patterns and extract knowledge from data.

For example, the SAP Predictive Maintenance and Service solution powered by SAP HANA harnesses the power of the IoT and M2M technology to analyze large volumes of operational data and apply predictive insights in real time. This solution can leverage sensors that monitor equipment behavior 24/7 to predict malfunctions, optimize asset maintenance and servicing, and automate operations.

The solution enables Kaeser Kompressoren SE, one of the world’s largest providers of compressed air systems, to do real-time monitoring of key parameters from each customer air station against minimum and maximum allowed values. The parameters include power consumption, operational availability and safety, and compressed air quality. Maintenance planning can be closely aligned with scheduled and current maintenance needs that are determined by the operating conditions of each air station. Machine health can be predicted individually for each compressor. The collected Big Data has also enabled Kaeser Kompressoren refine service processes and furnish valuable input for the development of next-generation equipment.

This solution is innovative for its computational complexity combined with the scale on which it operates. At Kaeser Kompressoren, the solution collects thousands of real-time data streams from customer air stations. The Big Data scales into the terabyte range, and the company analyzes and acts upon that huge amount of data as part of routine operations.
Smart Objects with Digital Object Memory

In addition to tracking manufacturing and test steps during production, smart products will track changes throughout their entire life cycle. This tracking information can identify the components of a product, the transportation used to move the product, any repairs made, and under what conditions the product was stored. Having this information available in the cloud will ensure visibility for all parties, from the producer to individual consumers.

At Kaeser Kompressoren, service engineers can analyze real-time parameters of their products without having to visit the customer site. This visibility accelerates the resolution of any problem. With the comprehensive view the portal provides, customer service personnel have become more proactive and more customer-oriented, ultimately making Kaeser more competitive. Additionally, air station performance reports generated by SAP HANA may be sent to customers, who can then verify service performance against service-level agreements.

IoT in an Open and Connected World

Extending the concept of process manufacturing, it might be useful to think about “manufacturing” concrete at a construction site. Can technologies such as the IoT help with this kind of process?

If so, the potential is enormous. According to a report on Chinese construction (The Construction Sector in China, EU SME Centre, 02.09.2013), the country is building 1.8 billion square meters per year of residential real estate alone, which represents “more than one third of all the buildings in the world, producing and consuming 55% of the world’s cement.”

Concrete is produced in plants with storage facilities and equipment to blend the raw materials. The concrete must be produced at the right time, loaded onto trucks, and delivered on time. Industry 4.0 concepts apply to many aspects of this process.

As shown in Figure above, the IoT can equip machines, facilities, and trucks with sensors and a network. The collected data can be used in an application such as SAP ERP to adjust production dynamically:

- To implement Just-in-Time (JIT) production, a concrete production plan is created dynamically based on demand from construction sites. If abnormal concrete pump operation is detected in the pump truck, the pumping rate can be reduced, which results in a change of the demand. On receiving the new demand information, the concrete plant adjusts the production plan. The delivery plan will also be adapted to best utilize the resources.

- To improve energy management at the concrete plant, the energy consumption of devices in the plant can be visualized and suggestions made for energy-saving measures based on cause analysis. For pump trucks,
delivery routes can be optimized to minimize fuel consumption.

- To improve protections for on-site workers, new safety rules can be created based on historical data collected by sensors. A real-time monitoring system can advise the operator on how to avoid potential risks.

This type of solution enables dynamic production adjustments, deceased energy and resource use, enhanced safety, and reduction of downtime through predictive maintenance.

![Image of Internet of Things Solution for Concrete Production at Construction Site](image_url)

**Connecting Things**

SAP’s vision in IoT is to deliver more than island solutions. SAP wants to deliver a whole IoT cloud platform based on SAP HANA, involving the entire ecosystem. SAP’s main focus areas are the software layers. SAP’s partners support solutions for connectivity and the hardware layers.

Data generated by the connected devices is collected via carrier services on the SAP HANA IoT Cloud Platform, which provides capabilities such as cost-effective data storage (hot/cold data, structured/unstructured data, and Big Data) and predictive analytics. On this platform SAP offers an open cloud application platform to handle tasks such as device integration and messaging, event processing, component reuse, and device management. Data and process integration for both SAP ERP and non-SAP applications are supported.

The key trend of the industrial world is to connect things: devices, processes, and businesses. IoT stands for increased connectivity and increased volumes of collected data — cheaper, faster, easier, and better than ever before.

China in particular has huge opportunities for the manufacturing industry to use the IoT to improve production, accelerate industry transformation, and upgrade to overcome emerging challenges such as increasing labor costs and lack of resources. Predictive maintenance and the IoT solution for
construction sites can bring real value to enterprises and enable improved manufacturing processes.