Powering up the assembly line

How the Internet of Things can help Chinese manufacturers compete

This document has been commissioned by Orange Business Services

April 2017

pwc

The Internet of Things helps Chinese manufacturers achieve operational excellence and improve competitive advantages

China's emergence as the world's largest producer of manufactured goods took place over a short span of just 30 years. During this time, abundant supplies of low cost labour, artificially cheap inputs to production and an undervalued currency[1] made China the choice location for the production of low-skilled, labour-intensive goods.

In order to meet global consumer demand, Chinese manufacturers focused on rapid expansion, and scale was achieved by hiring more workers and implementing higher level of specialisation of the workforce at each step of the manufacturing process rather than through capital investments and operational excellence.

However in recent years, China's manufacturing sector has started to stall[2] amidst slowing economic growth and rising costs[3], particularly in the more export-focused coastal regions. As an illustration, manufacturing wages have increased fourfold in dollar terms over the past decade[4] and factory real estate costs have risen exponentially after the government mandated minimum land prices[5]. These have been compounded by a gradual appreciation in the yuan – China's real effective exchange rate has appreciated by almost 30% since mid-2005[6].

All this is taking place amidst competition from upcoming low-cost producers in Asia such as Vietnam, as well as from technologically advanced economies such as Germany and the U.S.[7].

The nature of demand - both locally and globally - has also shifted in the last few years. In many markets, producing cheap is no longer good enough. Customers expect products that are inexpensive and at the same time offer a high degree of innovation, sophistication and quality.

In the context of these mounting pressures it is time for Chinese manufacturers find new ways to both protect their bottom line and sustain growth. One promising approach to do so is to harness digital technology to drive operational innovation.

The Chinese government is keen to support strategic investments in digital technology. The latest Five Year Plan for China's economy includes a "Made in China 2025" (MiC2025) initiative, which will make billions of yuan available for manufacturers to upgrade to technologies including advanced machinery and robots[8]. MiC2025 is supplemented by an "Internet+" strategy, which aims to integrate initiatives in key information technologies and to facilitate the adoption of smart technologies.

The time is ripe to explore how smarter technology can bring more value to Chinese manufacturers. While digital technology can take many shapes, including mobile technology, robotics, 3-D printing, cloud computing or big data, the Internet of Things in particular is very well suited to improve operations and enable Chinese manufacturers to compete for high-quality and high-complexity products.

Manufacturing industry in China

33%
of GDP [9]

15 %
of national workforce [10]

Made in China 2025[11]

According to the Centre of Strategic and International Studies, the MiC2025 initiative draws direct inspiration from Germany's "Industry 4.0" plan, which aims to achieve intelligent manufacturing by applying tools of information technology to production. MiC2025 aims to upgrade Chinese manufacturing industry, making it more efficient and integrated so that it can climb up the value chain ladder and manufacture more sophisticated products with higher margins.

The plan highlights 10 priority sectors in particular:

- **New advanced information technology**
- **Automated machine tools and robotics**
- **Aerospace and aeronautical equipment**
- **Maritime equipment and high-tech shipping**
- **Modern rail transport equipment**
- **New-energy vehicles and equipment**
- **Power equipment**
- **Agricultural equipment**
- **New materials**
- **Biopharma and advanced medical products**

China's upgrading effort is expected to raise comparatively greater challenges than Germany's, as the latter was technologically more advanced when it embarked on Industry 4.0. China has to address a few hurdles, such as shortage of relevant skills and displacement of low-skilled workers, that will require strong drive from the government. Besides analysis by the Mercator Institute for China Studies has shown that Chinese manufacturing is just transitioning from Industry 2.0, which is mainly characterised by the use of assembly lines, to Industry 3.0, which uses more industrial automation, electronics and information technology. To illustrate, there are 282 industrial robots to every 10,000 factory workers in Germany, as opposed to just 14 in China. Today, only 60% of Chinese companies use industrial automation software such as Enterprise Resource Planning[12]*.*

Despite the challenges, given the capital inflow and focus on manufacturing processes, it is only a matter of time until China's manufacturers are able to achieve greater efficiency through smarter automation.

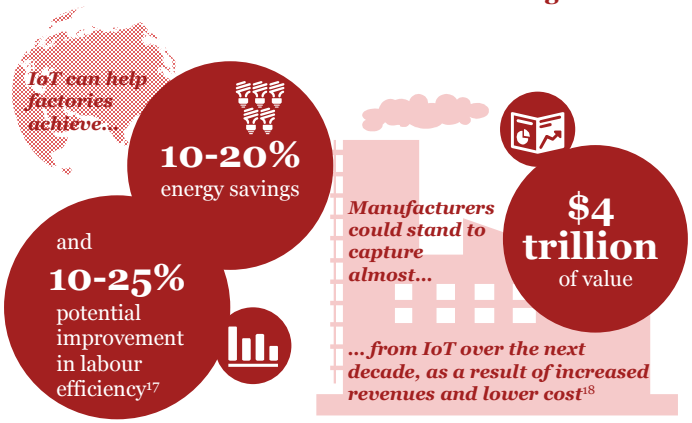
Increasing insight from the assembly line to enhance operations

Many Chinese manufacturers are introducing robotics and machinery to the production floor in order to increase productivity. As such investments take place, manufacturers can also leverage the Internet of Things and smart automation to achieve higher productivity. This refers to machines and sensors that collect data which in turn feeds into a backend database and processing infrastructure via the Internet to enable new levels of real-time production analysis[13].

For manufacturers that already have robotics and machinery in place, IoT can help them realise new value. By attaching intelligent devices to existing assets, manufacturers can collect data from previously untapped resources. For instance, manufacturing equipment can be enhanced with smart technology to monitor patterns forewarning a breakdown, such as unexpected vibrations or high temperature, and order replacement parts.

Smart machines and enabling technologies are increasingly affordable. For instance, computer processing and storage costs dropped from hundreds of dollars to tens of dollars since the introduction of cloud computing, while hardware costs are also decreasing for most devices[14].

Fast facts on IoT in manufacturing



As a consequence manufacturers can now obtain benefits from IoT technology with minimum capital investments:

Improving productivity

Process data, such as lead time or material consumption, can be collected from machines and sensors, filtered and sent to the cloud for storage and further analysis. It is possible to take this data and translate it into real-time dashboards, allowing for timely monitoring and control of factory processes and equipment, as well as generation of insights that can be used in enabling the optimisation of the plant.

For example, facilities managers can now have data-backed insight into all their operational events, including materials, equipment and operators' usage patterns – in real-time. This allows them to analyse processes, streamline workflows to reduce non-value added time and processes, reduce in-process inventory and establish performance management systems. The information can also be used by production personnel to better understand how temperature, pressure and humidity can impact performance and to minimise yield losses.

By using data-backed approaches, it is estimated that production capacity can be increased by as much as 65%[15].

Increasing energy efficiency

Real-time energy consumption can be tracked using IoT technology, so that the most energy-intensive assets are scheduled to run outside of peak-period when energy costs are at their highest.

At the same time, collecting utility usage information appropriately also enables manufacturers to determine the precise amount of energy used to produce a good and to use this as an input when analysing profitability.

Climbing the IoT ladder[16]

Chinese manufacturers currently operate at different rungs of the IoT evolution.

Data ubiquity now… and in the future

- Data collection / analytics pervading supply chain and distribution
- New technologies adopted for greater connectivity (e.g., 3-D sensors, collaborative and social software, augmented reality, location awareness, 3-D data visualizations, etc.)
- Increased machine-to-machine (M2M) data exchange between advanced manufacturing equipment (robots, 3-D printers, etc.)
- Increased adoption of product-monitoring service business models

Actionable data delivered to decision makers

- Data consolidated through platforms accessible to all relevant stakeholders (e.g. alert via email for possible machine failures), scalable and also combined with data from external sources (e.g., weather information) as relevant
- Self-correcting, self-healing and self-maintaining features enabled in real-time for smart machines

Data gathering and analysis

- Collection, storage, and organisation of data, using software, cloud servers – private, public or hybrid
- Real-time performance monitoring and analysis of plant equipment, materials and processes, and energy use on granular level

Data hunting

- Identification of data that needs to be captured
- Deployment of data collectors (Internet-connected sensors, controllers, cameras, gauges, smart phones, tablets, etc.)
- Data connectivity through wired and wireless (e.g., ZigBee, Wi-Fi, mobile phone, local networks, and Internet)

Enabling cross-facilities benchmarking

Using IoT, data from multiple factories can be collected and consolidated in the cloud. This consolidated data then enables cross-factory monitoring and benchmarking, and eventually the identification of high-performing or under-performing facilities. Data patterns specific to these facilities can be singled out, which facilitates the identification of best practices to be shared across the network or the remediation of deficiencies.

Reducing error and waste using self-correcting machines

Smart machines can also be programmed to self-monitor and self-correct, enabling a range of other improvements:

Increasing quality control and decrease failure rate

Quality and automation are particularly important for higher-end products and are key enablers for Chinese manufacturers to move up the global production chain. As an example, the Chinese lithium-ion batteries industry lags behind its South Korean and Japanese counterparts in terms of level of automation, leading to poorer quality control[19].

It is possible to embed intelligence within equipment, so that quality inspection can be executed automatically in real-time, triggering immediate reactions to defective products and materials. For instance, once a major quality control issue in a production line is detected, the line may be shut down before it continues to create faulty products that will be wasted. Such automation serves to error-proof processes and even enables external supplier quality management.

Studies have shown that related controls can reduce reject rate by 75%, validation time from two weeks to two hours, and yield substantial monthly savings[20].

Enabling efficient maintenance

When equipment failure occurs, data can be gathered and analysed in real-time in order to automatically recommend repair actions. This facilitates decision-making by providing alternate courses of action, and greatly reduces average downtime as well as cost of repairs.

IoT in manufacturing – the Japanese example

Japanese manufacturers have been pioneering the use of IoT to improve their capabilities.

As an example, in Mitsubishi Electric's factory in Nagoya, Japan, automation solutions e-F@ctory and eco-F@ctory were developed and deployed in order to optimise and strengthen manufacturing and production processes. E-F@ctory refers to a set of control and network technologies that enabled the visualisation of production information, and the incorporation of these information into production plans so as to ensure quality traceability. Eco-F@ctory refers the "visible" management of power usage through the introduction of measuring equipment and technologies that support energy conservation efforts.

Overall, the human-robot collaboration resulted in:

- 50% reduction in lead time
- 180% increase in productivity
- 190% increase in equipment operating rate
- 60% decrease in manufacturing schedules
- 10% reduction in energy cost[21]
- 50% reduction in quality loss [22]

Sensors can also be used to continuously monitor equipment throughout its lifecycle in order to assess operating conditions. Whenever abnormal or undesired behaviour is identified, the data can be analysed automatically to identify accurately potential snags, defects or breakdowns.

The system can then prompt an appropriate preventive maintenance action in order to decrease the risk of breakdown, which minimises unscheduled downtime and increases throughput.

IoT-based predictive maintenance has been shown to reduce downtime by 50% and increase production capacity by 65%, as a result of shortened planned maintenance and production lines running for longer periods of time[23].

Going further, networked devices can process data where it is collected and take independent action without manual assistance[28]. In many maintenance situations, machine systems can be self-diagnosing and self-adjusting. As an example, smart equipment can identify that its battery is overheating and start operating with a lower intensity in order to contain the increase of temperature while waiting for replacement part.

Besides saving time and expense, this technology can prevent emergencies, and employees can then focus on value-adding activities such as supervision and handling of unexpected incidents.

Reducing business risk

Production environments with embedded intelligence can take health and safety compliance to zero tolerance level. Such environments improve accident prevention as well as real-time detection, investigation and resolution of near-miss incidents.

IoT in manufacturing – examples in China

Use of IoT amongst Chinese manufacturers is not yet widespread but several market leaders have announced plans to implement smart equipment, including:

- Foxconn Technology Group, the world's largest electronics contract manufacturer, plans to introduce more automation, cloud computing and services to drive long-term growth[24] . It recently replaced 60,000 factory workers with robots and workers were instead moved to higher value-added elements in the manufacturing process, such as research and development, process control and quality control[25].

- In 2016, Huawei, the Chinese technology and smartphone giant, signed a deal with an equipment provider to help improve production. Huawei is expecting to connect all areas within a production process via the Internet in order to improve productivity, lower costs and reduce emissions. Improvements are expected to help save US$ 500m a year[26].

- Siasun, China's leading robot maker, and Schneider Electric signed an agreement in 2016 to build smart factories in China, starting with the modernisation of the industrial base in Liaoning province, where Siasun is headquartered[27].

Improving production planning through smart supply chain

Sensor data can be combined with Global Positioning System (GPS) and Radio Frequency Identification (RFID) technologies in order to provide real-time visibility and traceability of events related to supply chain. While the use of tracking technologies is already established in companies' supply chains, IoT enables richer data and deeper intelligence for all parties in a supply network and across factories[29].

The data gathered allows manufacturing companies to automate shipping and delivery by exactly predicting the time of arrival from suppliers, factories and warehouses, and then adjusting production processes accordingly so as to optimise asset and labour utilisation. Manufacturers can also use the data to track raw materials, coordinate faster deliveries and shorten cycle time. Use cases[30] show that IoT can help improve cycle times by up to 28%.

The application of smart technologies to a manufacturer's supply chain can extend beyond positional information of goods.

Technologies can also help monitor the condition of every item in transit to a smart factory.

For instance, sensors can help detect if the cargo has been exposed to excessively high temperatures and humidity which may in turn affect its quality. The smart factory pinpoints potential issues before inputs are expected into a production line and takes alternative supply decisions to replace compromised material[31].

Smart technologies also allow manufacturers to offer more value to other stakeholders downstream[32]. For instance, manufacturers, distributors and retailers can use a shared tagging system to achieve real-time visibility over inventory as goods move through every link in the supply chain.

This level of collaboration is particularly beneficial in industries where demand is seasonal, such as in retail. Products in these industries have a limited window of opportunity to be sold, and real-time replenishment requests from retailers allow manufacturers greater flexibility and agility to meet the demand while controlling inventory costs[33].

IoT has now reached an age of maturity and is becoming an essential component of the assembly line for manufacturers all over the world. In China alone, manufacturing enterprises' spending on the Internet of Things is expected to reach US$127.5 billion by 2020, with a compound average growth rate of 14.7% between 2016 and 2020[34].

Chinese manufacturers today seek to move up the value chain and compete for higher value manufacturing contracts. It is increasingly evident that digital technology, in particular the Internet of Things, will play a key role in achieving this goal, as it has tremendous potential to improve operational efficiency, facilitate supply chain integration and eventually build new and innovative capabilities to move up the value chain.

Adoption of digital technology may well prove to be the differentiator that dictates whether China remains the "World's Factory" in the years to come.

References

1. http://www.treasury.gov.au/PublicationsAndMedia/Publications/2012/Economic-Roundup-Issue-4/HTML/article4
2. https://www.technologyreview.com/s/601215/china-is-building-a-robot-army-of-model-workers/
3. http://www.worldfinance.com/markets/a-tough-road-ahead-for-chinas-manufacturing-industry
4. http://www.worldfinance.com/markets/a-tough-road-ahead-for-chinas-manufacturing-industry
5. http://dupress.com/articles/manufacturing-beyond-china/
6. http://www.treasury.gov.au/PublicationsAndMedia/Publications/2012/Economic-Roundup-Issue-4/HTML/article4
7. http://www.industrysourcing.com/article/smart-manufacturing-china
8. https://www.technologyreview.com/s/601215/china-is-building-a-robot-army-of-model-workers/
9. http://www.worldfinance.com/markets/a-tough-road-ahead-for-chinas-manufacturing-industry
10. http://www.worldfinance.com/markets/a-tough-road-ahead-for-chinas-manufacturing-industry
11. https://www.csis.org/analysis/made-china-2025
12. http://knowledge.ckgsb.edu.cn/2015/09/02/technology/made-in-china-2025-a-new-era-for-chinese-manufacturing/
13. Strategy&, 2016 industrial manufacturing trends
14. The Internet of Things can Drive Innovation—If you understand sensors, Altera website, https://www.altera.com/solutions/technology/system-design/articles/_2014/internet-things-drive-innovation.html
15. http://literature.rockwellautomation.com/idc/groups/literature/documents/wp/cie-wp007_-en-p.pdf
16. PwC publication: The Internet of Things: what it means for US manufacturing, http://www.themanufacturinginstitute.org/~/media/659A17245F6F4375BCCE889079427CB6/Data_Driven_Manufacturing_Whitepaper.pdf
17. McKinsey Global Institute, The Internet of Things: Mapping the Value Beyond the Hype, June 2015, http://www.mckinsey.com/~/media/McKinsey/Business%20Functions/Business%20Technology/Our%20Insights/The%20Internet%20of%20Things%20The%20value%20of%20digitizing%20the%20physical%20world/Unlocking_the_potential_of_the_Internet_of_Things_Executive_summary.ashx
18. ARC Advisory Group, Internet of Things (IoT) Could Enable $3.88 Trillion in Potential Value to Manufacturers, March 2014.
19. http://knowledge.ckgsb.edu.cn/2015/09/02/technology/made-in-china-2025-a-new-era-for-chinese-manufacturing/
20. http://literature.rockwellautomation.com/idc/groups/literature/documents/wp/cie-wp007_-en-p.pdf
21. http://dl.mitsubishielectric.com/dl/fa/document/catalog/sol/efactory/l16023/l16023eng-a.pdf
22. http://dl.mitsubishielectric.com/dl/fa/document/catalog/sol/efactory/l16012/l16012e-c.pdf
23. https://www.intel.co.uk/content/www/uk/en/internet-of-things/blueprints/iot-increase-manufacturing-performance-blueprint.html
24. http://www.bloomberg.com/news/articles/2015-06-25/foxconn-s-gou-to-tap-smart-manufacturing-in-move-beyond-labor
25. http://www.bbc.com/news/technology-36376966
26. http://www.digitallook.com/news/international-companies/general-electric-teams-up-with-huawei-to-improve-production--1633232.html
27. http://ss.gtzc.net.cn/En/news/info1455940161.html
28. https://www.intel.co.uk/content/www/uk/en/internet-of-things/solution-briefs/smart-manufacturing-solutions-top-10.html
29. http://www.inboundlogistics.com/cms/article/how-the-internet-of-things-impacts-supply-chains/
30. http://literature.rockwellautomation.com/idc/groups/literature/documents/wp/cie-wp007_-en-p.pdf
31. http://memeburn.com/2016/05/smart-manufacturing-intelligent-connected-supply-chain/
32. https://www-07.ibm.com/sg/manufacturing/pdf/manufacturing/Auto-industry.pdf
33. https://www.zebra.com/content/dam/zebra_new_ia/en-us/solutions-verticals/product/RFID/GENERAL/White%20Papers/WP_Item-Level_Supply_Chain_0413.pdf
34. http://www.idc.com/getdoc.jsp?containerId=prCHE41707816

About PwC

PwC helps organisations and individuals create the value they're looking for. We're a network of firms in 157 countries with more than 200,000 people who are committed to delivering quality in assurance, tax and advisory services. For more information, please visit www.pwc.com.

PwC refers to the PwC network and / or one or more of its member firms, each of which is a separate legal entity. Please see www.pwc.com/structure for further details.

Contacts

Alan Huang
Phone: +65 8338 8329
Email: alan.hc.huang@sg.pwc.com

Mohammad Chowdhury
Phone: +62 811 8083430
Email: mohammad.chowdhury@id.pwc.com

www.pwc.com/sg