China’s smart manufacturing: a steady push for the long term
—2018 China smart manufacturing report
Part of a Deloitte report series on industry 4.0, digital manufacturing enterprises and digital supply networks
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China's smart manufacturing: a steady push for the long term

Key findings

1. The development of smart manufacturing has produced remarkable results, ushering in a period of rapid growth. The growth of smart manufacturing in China is manifested in three main aspects. First, Chinese industrial enterprises have benefited from a higher level of digital capacity and quality, laying a strong foundation for the future analysis, prediction and self-adaptation of manufacturing systems. Second, in terms of financial benefits, smart manufacturing is making a much greater contribution to corporate profitability. Third, in terms of typical applications, China has become the largest consumer of industrial robots, supported by fast-growing demand.

2. The five focus areas of smart manufacturing deployment among Chinese industrial enterprises are digital factory (63%), in-depth extraction of equipment and user value (62%), industrial internet of things (IoT) (48%), business model restructuring (36%) and artificial intelligence (AI) (21%).

3. Intelligent manufacturing operations are at the core of smart manufacturing, underlined by end-to-end data flows with digitalization as a key driving force. Against this backdrop, enterprises are now giving the digital factory top priority in smart manufacturing deployment as they focus on securing seamless data flows from production to execution, with tremendous room to improve product and supply chain data flows.

4. Amid growing market competition and increasingly transparent product pricing, manufacturers have little alternative but to seek new sources of value. As the Deloitte Smart Manufacturing Survey shows, in-depth extraction of equipment and user value is the second priority in deployment of smart manufacturing, with 62% of interviewed enterprises actively focusing on these issues, 41% on equipment value and 21% on user value.

5. Chinese manufacturers are not active in cloud deployment. Of the manufacturers surveyed, 53% have not yet deployed industrial clouds and 47% are now deploying an industrial cloud. Of the clouds under deployment, 27% are private, 14% are public and 6% are hybrid clouds.

6. Smart manufacturing can not only help manufacturers reduce costs and increase efficiency, but also gives them an opportunity to rethink their value propositions and restructure their business models. The Deloitte survey found 30% of enterprises are turning to a platform-centric business model, 26% adopting mass customization model, 24% transforming into solutions providers centered on “products and services” and 12% focusing on intellectual property rights.

7. AI influences manufacturing in two main ways, by improving quality and efficiency in manufacturing and management processes and completely disrupting the product and service industry landscape. As revealed in the Deloitte Smart Manufacturing Survey, 51% of enterprises are already using AI in manufacturing and management and 46% have started or are working on deploying AI to empower their products and services.

8. Business model restructuring is a complex and arduous task, with business model optimization, innovation management and cloud deployment the three key elements of corporate capacity building.

Smart manufacturing is a collective term for advanced manufacturing processes, systems and models, based on a new generation of information technology and covering the gamut of manufacturing activities from design and production to management and services. It is characterized by a range of functional capabilities such as self-perception of deep information, smart-based optimum self-decision making and precision-controlled self-execution. Simply put, smart manufacturing represents an intelligent product, tool and service supported by the IoT system.

Smart manufacturing has become an important choice for countries amid the restructuring of global value chains and changing global division of labor. Developed countries have stepped up efforts to bring manufacturing back home and enhance the strategic importance of manufacturing in their national economies. As a key manufacturing hub, Asia is also actively deploying automation and intelligent technologies.
I. Breakthroughs and growth

A rising tide of automation and intelligence is sweeping across Asia. An International Labor Organization (ILO) study found that workers in Vietnam, Cambodia, the Philippines and Indonesia are at the highest risk of losing their jobs, with automation likely to replace an estimated 50% of workers in these regions in the next 20 years.

Can Asia, as an important manufacturing hub, stay competitive amid this growing shift to manufacturing automation, intelligence and digitization?

There is no doubt Asia is actively seeking breakthroughs. Take AI for example. Governments in Asia strongly support AI applications and the innovation drives of tech companies, start-ups and academia. In 2017, the South Korean government announced AI funding of USD1 billion and Japan encouraged the participation of start-ups and venture capitalists in AI. The National Research Foundation sponsored by the Singaporean government has unveiled a national AI program (AI.SG), with plans to invest SGD150 million (approximately USD107 million) in the development of AI over the next five years.

With government support, Asian companies have become more active in breaking down industry barriers and speeding up new product development. Unlike their counterparts in Europe and the US, leading Chinese companies are well-known for building cooperative relationships, with prominent examples including the joint efforts of Baidu and Xiaomi to develop more IoT and AI application scenarios; the venture between Tencent and JD.com to build an e-commerce ecosystem; and the formation of AI leagues (e.g. OpenAI) with Indian systems integrators. This level of cooperation has empowered Chinese companies greatly, giving them the technological capability and capital resources required to drive rapid innovation.

China is an important force in Asia's growing shift to intelligent applications. The Chinese government has strengthened the top-level design of smart manufacturing, embarked on pilot schemes and demonstrations and is developing standard systems. For their part, enterprises have accelerated the pace of digital transformation and improved their system solution capabilities. Smart manufacturing has achieved remarkable results in China, ushering in a period of rapid growth.

The growth of smart manufacturing in China has three main aspects. First, Chinese industrial enterprises have benefited from a higher level of digital capacity and quality, laying a strong foundation for the future analysis, prediction and self-adaptation of manufacturing systems. Second, in terms of financial benefits, smart manufacturing is making a far greater contribution to corporate profitability. Third, in terms of typical applications, China has become the largest consumer of industrial robots, supported by fast-growing demand.

**Improved digital capacity and quality**

The ability to use data to guide the production process and the ability of a system to optimize itself reflect the capacity and quality of digitalization. Based on the internationally accepted development path of Industry 4.0, the maturity of intelligence applications at the corporate level has six stages: computerization, connectivity, visualization, transparency, prediction and self-adaptation.

**Figure 1.1 Development path of Industry 4.0**

Source: Deloitte Analytics
• **Computerization:** Repetitive work processes can be performed most efficiently through computerization to realize high precision, low-cost manufacturing. However, many devices do not have digital interfaces as different IT systems run independently within an enterprise.

• **Connectivity:** Disconnected information technology operations are fast giving way to interconnected operations. All parts of the operation technology (OT) system are now interconnected and interoperable, but full integration of IT and OT has yet to be achieved.

• **Visualization:** By acquiring an understanding of what is happening and leveraging IoT technologies such as fieldbuses and sensors, an enterprise can capture large amounts of real-time data and develop “digital twins”, switching to digital-based decision-making away from the conventional approach based on human experience.

• **Transparency:** The generation of knowledge based on root cause analysis and understanding the cause of an incident.

• **Prediction:** Projecting digital twins into the future, predicting the future by simulating different scenarios, making decisions and responding appropriately and swiftly.

• **Self-adaptation:** The ability to predict is only the most fundamental requirement for automated behavior and decision-making. Continuous self-adaptation enables an enterprise to respond autonomously and adapt as soon as possible to changes in the business environment.

With the integration of IT and industrialization in China and the development of the industrial IoT, among other initiatives, manufacturers have made massive improvements to their digital capacity and quality, with the majority now focusing on vertical integration of data. As revealed in the Deloitte survey, 81% of respondents have completed computerization. Of these enterprises, 41% are in the connectivity stage, 28% in the visualization stage and 9% are in the transparency stage. Enterprises in the prediction stage and self-adaptation stage each account for 2%.
China’s smart manufacturing: a steady push for the long term  | I. Breakthroughs and Growth

Smart manufacturing is now contributing a much larger share of profits
Upgrading to Industry 4.0 brings real, visible benefits to manufacturers. In a Deloitte survey of 200 manufacturers across the country in 2013, smart manufacturing in China was found to be in its infancy, generating meagre margins. However, after five years of rapid development, the ability of smart manufacturing to produce profitable products and services has risen sharply. The profits brought to enterprises by smart manufacturing were not obvious in 2013 when 55% of surveyed businesses reported a contribution of 0%-10% to net profit through products and services derived from smart manufacturing. In comparison, only 11% of respondents in 2017 reported a profit contribution in this range, whereas 41% reported a profit contribution of 11%-30%. As a percentage of respondents, enterprises reporting a profit contribution of more than 50% rose from 14% in 2013 to 33% in 2017. The profit contribution of smart manufacturing has risen markedly, a result of increased production efficiency and higher value products and services.

Figure 1.2 The Industry 4.0 progress of enterprises (self-assessment)
At what stage of Industry 4.0 is your enterprise?

Source: Deloitte Smart Manufacturing Enterprise Survey 2018

Figure 1.3 Smart manufacturing products and services making a much larger contribution to profits

Profit contribution of smart manufacturing

Source: Deloitte Smart Manufacturing Enterprise Survey 2018
China's smart manufacturing: a steady push for the long term

I. Breakthroughs and Growth

Market potential of applications

China has been the largest consumer of industrial robots for six years in a row. The Chinese market for industrial robots was valued at USD4.2 billion in 2017, or 27% of the global market, and will expand to USD5.9 billion by 2020, according to data from the International Federation of Robotics (IFR). Robot sales are expected to reach 160,000, 195,000 and 238,000 units in China in 2018, 2019 and 2020 respectively, representing a CAGR of 22%. Automobile, advanced equipment manufacturing, and electronics and electrical appliances remain the major users of industrial robots.

But what unique advantages does China have in this area? The first is the huge volume of data it can access. The machine learning technology behind the current AI boom is heavily dependent on data. Facial recognition, language translation and autonomous vehicle pilot programs all require a huge amount of "training data". Given China's huge population and massive equipment resources, Chinese companies have a natural advantage in accessing data. Secondly, manufacturing plants and equipment in China are newer than in Europe and the US, making equipment connection and retrofitting easier.

"Thanks to a massive pool of engineers, a sound industrial infrastructure, and the potential of the huge volume of data available, China's industrial IoT development has taken the lead on the race track not by 'successfully maneuvering sharp bends' but by 'switching lanes'."

— Li Yizhang, Chairman of Sysware
II. Focus of smart manufacturing deployment

As revealed in the Deloitte survey, the deployment of smart manufacturing by Chinese industrial enterprises is concentrated in five key areas: digital factory (63%), in-depth extraction of equipment and user value (62%), industrial IoT (48%), business model restructuring (36%) and AI (21%). Related technologies of interest include industrial software, sensor and communications technology, AI, IoT, and big data analytics. However, we cannot assume merely using these technologies will realize smart manufacturing, because changing to a new manufacturing culture is a relatively complex, slow process, requiring integrated operations and promotion across industries, enterprises and users.

Figure 2.1 Focus of smart manufacturing deployment

![Figure 2.1 Focus of smart manufacturing deployment](source)

Source: Deloitte Smart Manufacturing Enterprise Survey 2018

Figure 2.2 Technologies of interest

![Figure 2.2 Technologies of interest](source)

Source: Deloitte Smart Manufacturing Enterprise Survey 2018
2.1 Digital factory

Intelligent manufacturing operations are at the core of smart manufacturing, underlined by end-to-end data flows with digitalization as a key driving force. With this in mind, enterprises are now giving digital factories for deployment of smart manufacturing top priority as they focus on securing seamless data flows from production to execution, with huge room to improve product and supply chain data flows.

With the support of a new generation of information technology, a digital factory connects data through design, production, logistics, servicing and other processes, enabling more efficient, accurate decision-making. Only by accessing seamless data flows can the production process be optimized for real-time changes in data, better coordination of business, technology and cash flow processes, as well as the dynamic allocation of production resources (materials, energy etc.) internally and among different enterprises.

Ensuring seamless data flows is a prerequisite for creating a factory digital twin. This refers not only to product digitalization, but also digitization of the factory itself as well as the technological process and equipment involved, designed to achieve comprehensive traceability and the physical and virtual sharing and communication of information.

Seamless data flows entail the interconnection of three types of data across production, products and supply chains.

- Production process data

Seamless production data flows include not only data flows from production planning to execution (such as ERP to MES), but also data flows between an MES and control/monitoring devices, between field devices and control devices and between an MES and field devices.

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**Figure 2.3 Major types of production data flow**

<table>
<thead>
<tr>
<th>Data flow</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data flows between MES and control/monitoring devices</td>
<td>The MES sends work instructions, parameter configurations, prescription data and other information to control devices; control devices deliver data relating to production operations to the MES, and monitoring devices transmit diagnostic and alarm information to the MES.</td>
</tr>
<tr>
<td>Data flows between control devices and field devices</td>
<td>Field devices include all kinds of sensors, CNC machine tools, industrial robots, process equipment, intelligent storage and other manufacturing equipment. There is a two-way exchange of input and output data, including the transmission of set-up values (output data) from control devices to field devices, and transmission of measured values (input data) from field devices to control devices; control devices can access parameter data on field devices; and field devices deliver diagnostic and alarm information to control devices.</td>
</tr>
<tr>
<td>Data flows between MES and field devices</td>
<td>The MES sends work instructions, parameter configurations and other data to field devices; field devices send production-related data on quality, inventory and equipment status to the MES.</td>
</tr>
</tbody>
</table>

Sources: Public information, Deloitte Analytics
China's smart manufacturing: a steady push for the long term

II. Focus of Smart Manufacturing Deployment

• **Product data flows**
  Digitalization and traceability throughout the entire lifecycle of a product are the main manifestations of seamless product data flows. Lifecycle digitalization aims to shorten the R&D cycle, mainly in product R&D and building product lifecycle management systems (PLM) through model-based definition (MBD). R&D is the starting point of a digital factory’s "data chain". Data generated during R&D is transmitted in real time across the various factory systems. The synchronous data update helps avoid the kind of errors common to traditional manufacturing enterprises caused by poor communication. It also improves factory efficiency substantially and hastens product development. Product lifecycles have become traceable, focusing on better product quality control.

  A unique identification mark, one of the main applications of product data technology, is assigned to a product throughout its lifecycle. Sensors, intelligent instruments and meters as well as industrial control systems autonomously gather the data required for quality management. Online quality tests are conducted and early warnings are disseminated through the MES.

• **Supply chain data**
  The synergistic optimization of a supply chain’s upstream and downstream operations to achieve network-coordinated manufacturing is the main result of seamless supply chain data flows. The main application is to build a collaborative platform for cross-enterprise manufacturing resources and realize the integration and interconnection of the R&D, management and service systems of different enterprises, providing enterprises connected to the platform with R&D design, operation management, data analytics, knowledge management, information security and other services, and carrying out dynamic analytics and flexible configuration of manufacturing services and resources.

  Our survey reflects a corporate commitment to achieving seamless data flows from ERP to MES and even field devices, with a view to smoothing the process from production to execution. The need to integrate product data and supply chain data will arise. We divide production data flows into two types: one involving seamless data flows between production planning and execution systems, the other involving data flows from operation/monitoring and field devices. According to the survey, 83% of respondents have achieved seamless data flows from ERP to MES and 62% are still building seamless data flows from MES to field devices. This compares with only 47% who have achieved seamless product data flows and 44% who have achieved seamless supply chain data flows (Figure 2.4). Given the surveyed companies are of higher quality and above average size, these figures are clearly above the overall averages in China.

**Figure 2.4 Data connectivity (overall)**

| 83% | 83% of surveyed enterprises have achieved seamless ERP-MES data flows |
| 62% | 62% have built seamless data flows from production planning through execution to field devices |
| 47% | However, only 47% have built seamless product data flows |
| 44% | 44% have achieved seamless supply chain data flows |

Source: Deloitte Smart Manufacturing Enterprise Survey 2018
By industry, the aerospace enterprises interviewed have all achieved seamless data flows from production planning to execution, but have been slow to engender seamless data flows from production execution to field devices, products and supply chains, leaving much room for improvement. The level of seamlessness in product and supply chain data flows in electronic components and electrical appliances manufacturing is higher than in other industries, as is the overall level of manufacturing digitalization. Product quality is arguably the lifeline of the pharmaceutical industry, but only 33% of surveyed pharmaceutical companies have seamless product data flows. The industry needs to strengthen product lifecycle traceability and improve product quality control capabilities.

Manufacturers of automobiles, auto parts and advanced equipment lead the way in building seamless product data flows (Figure 2.5).

**Figure 2.5 Data connectivity* (by industry)**

<table>
<thead>
<tr>
<th>Industry</th>
<th>Data flows from production planning to execution</th>
<th>Equipment data flows</th>
<th>Product data flows</th>
<th>Supply chain data flows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace</td>
<td>100%</td>
<td>38%</td>
<td>25%</td>
<td>13%</td>
</tr>
<tr>
<td>New materials</td>
<td>92%</td>
<td>54%</td>
<td>46%</td>
<td>31%</td>
</tr>
<tr>
<td>Electronics &amp; electrical appliance</td>
<td>86%</td>
<td>81%</td>
<td>62%</td>
<td>57%</td>
</tr>
<tr>
<td>Pharmaceuticals</td>
<td>83%</td>
<td>50%</td>
<td>33%</td>
<td>50%</td>
</tr>
<tr>
<td>Automobiles &amp; auto parts</td>
<td>80%</td>
<td>67%</td>
<td>53%</td>
<td>40%</td>
</tr>
<tr>
<td>Advanced equipment manufacturing</td>
<td>68%</td>
<td>53%</td>
<td>58%</td>
<td>47%</td>
</tr>
</tbody>
</table>

* Percentages represent proportion of companies in each industry with seamless data flows

Source: Deloitte Smart Manufacturing Enterprise Survey 2018
Digital twin

In future, the digital world and physical world will become one. Seamless data flows are the basis of digital twin operations. Deloitte sees the digital twin as a quasi-real-time, virtual representation of a physical object or process that contributes to improved corporate performance. A digital twin is often based on a multi-level but highly centralized data model, encompassing products, technological production processes and equipment.

In production, Tesla has built a digital twin model for every electric vehicle it makes and sells, with corresponding model data stored in the company's database. The experience each electric vehicle gathers is reported every day and the data applied using a digital twin simulator to detect and correct anomalies. Through digital twin simulation, experience from the equivalent of a 1.6 million mile drive can be acquired each day and fed back to each car as part of ongoing learning. During production, digital twins have started to be introduced into technology-sensitive manufacturing operations and production lines. Before construction work begins, simulation and modelling simulates the best factory construction process, with real parameters used as a reference for actual construction to reduce errors and risks. After completion of the plant and production lines, day-to-day operations and maintenance interact through digital twinning, making it possible to quickly spot problems and improve work efficiency.

According to a Gartner survey of 202 companies in the US, Germany, China and Japan, at least 50% of those with annual revenue of more than US$5 billion expect to launch at least one digital twin project for their products or assets by 2020. By then, the number of companies using digital twin technology will have increased threefold. In the next few years, hundreds of millions of users will resort to digital twin operations, with the technology used by enterprises to, among other tasks, plan equipment services, facilitate production operations, forecast equipment failures, improve operational efficiency and accelerate new product development. In future, this technology is expected to be completely integrated with industrial production, lifting smart manufacturing to a new level.

How to create a digital twin? Deloitte believes this involves two main areas of interest:
01. The digital twin design process and product lifecycle data requirements—from asset design to on-site utilization and maintenance of assets in the physical world; and
02. The creation of enabling technologies to integrate real assets and their digital twins, realizing real-time flows between sensor data and operational and trading information in an enterprise's core system.

"The implementation of the smart factory concept is dictated by the acuteness of an enterprise's demand. While some enterprises are desirous of improving product quality, some others look to realize the digitalization of product design, production and management. For enterprises finding it difficult to adopt a 'once-and-for-all' solution, the resolution of immediate problems should take priority, with long-term planning in place to manage the possible consequences of failing to achieve interconnectivity in the future."

—— Zhu Yiming, Chief Engineer of HollySys Group
2.2 **In-depth extraction of equipment and user value**

Amid growing market competition and increasingly transparent product pricing, manufacturers have little alternative but to seek new sources of value. As the Deloitte Smart Manufacturing Survey shows, in-depth extraction of equipment and user value is the second priority in smart manufacturing deployment, with 62% of enterprises actively focusing on extracting equipment and user value (41% on extracting equipment value and 21% on extracting user value).

Extracting value from equipment is manufacturers’ lifeblood. For example, R&D design incorporates new technology to produce smarter or more diversified products. At the sales stage, equipment-related financial services can be provided. After sales, data on equipment and products shipped from the factory are collected and monitored in real-time. Performance analysis and predictive maintenance can then improve security and create more service opportunities for the enterprise.

Although a later mover, manufacturers are attempting in-depth extraction of user value, most prominently in C2M (customer-to-manufacturer). This is akin to customized production where manufacturers deal directly with customers to meet their individual needs, cutting costs and improving efficiency by reducing intermediate processes.

Red Collar Group has realized mass customization via a C2M e-commerce platform coupled with flexible supply capacity and big data capability. Customers can choose clothing styles, technologies and materials, and place orders all through the C2M e-commerce platform. As the platform rapidly gathers information on scattered, individualized customer demands, big data and cloud computing are at work to match product data models with customer needs. Information on styles and technologies can satisfy more than a million design combinations, covering 99.9% of individualized needs.

When a design is determined, the system automatically generates and sends process data to the factory for production and delivery. The whole process from order placing to shipment takes only seven days. The factory produces on-demand and maintains zero inventory, able to produce one design for one person and one style for one garment.

Alibaba’s “Tao Factory” platform, which links tens of thousands of manufacturers, matches e-commerce orders with manufacturers’ production capacity by making flexible production capacity and schedule data accessible on-line, solving the difficulties of matching manufacturers with e-commerce orders and manufacturer orders with production capacity.

2.3 **Industrial IoT**

Smart manufacturing calls for manufacturing systems with sensory, analysis, decision-making and execution capabilities. These all involve technologies related to the IoT, such as sensory-oriented IoT (sensors, RFID and chips), analytics-oriented industrial big data analysis and application platforms oriented to decision-making and services.

Our survey shows that the current IoT applications of Chinese manufacturers are sensory-oriented, with a combination of analytics and services expected to become the focus of IoT development. In general, enterprises have created a system to collect sensor-based dynamic data, but lag behind in data analysis and platform applications. Sensors and platforms are the most widely used applications in the electronics and electrical appliances sector, with 76% of enterprises using sensors to collect data, 43% using an IoT platform and only 33% using big data technology to analyze the data gathered. Sensor technology applications have a high penetration rate of 73% in automobile and auto parts manufacturing, but it lags behind other sectors in big data and platform applications. The pharmaceuticals industry, already challenged by massive data flows and unstructured data, is the most active user of big data technologies (Figure 2.6).

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**Figure 2.6 Application of typical IoT-related technologies**

<table>
<thead>
<tr>
<th>Industry</th>
<th>Sensor Technology</th>
<th>Big Data</th>
<th>IoT Platform</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electronics &amp; electrical appliances</td>
<td>76%</td>
<td>33%</td>
<td>43%</td>
</tr>
<tr>
<td>Automobile &amp; auto parts</td>
<td>73%</td>
<td>20%</td>
<td>13%</td>
</tr>
<tr>
<td>Advanced equipment manufacturing</td>
<td>68%</td>
<td>32%</td>
<td>32%</td>
</tr>
<tr>
<td>Pharmaceuticals</td>
<td>67%</td>
<td>50%</td>
<td>33%</td>
</tr>
<tr>
<td>Aerospace</td>
<td>50%</td>
<td>25%</td>
<td>38%</td>
</tr>
<tr>
<td>New materials</td>
<td>31%</td>
<td>31%</td>
<td>31%</td>
</tr>
</tbody>
</table>

Source: Deloitte Smart Manufacturing Enterprise Survey 2018
Sensory capability marks only the initial stage of IoT applications. Actions guided by data insights for higher efficiency, or the creation of new value through integration with services, are at the core of IoT. A cloud platform provides powerful data transmission, storage and processing capabilities, helping manufacturers collect and process massive data. An industrial cloud platform not only enables enterprises to design, process, manufacture, purchase and market products through the platform, but also reshapes the traditional production and manufacturing ecosystem to create new revenue sources and business models. So, what is the current status of cloud deployment among Chinese manufacturers?

According to our survey, Chinese manufacturers are not active in cloud deployment. 53% have not yet deployed industrial clouds, and 47% are now deploying an industrial cloud. Of the clouds under deployment, 27% are private, 14% public and 6% are hybrid clouds (Figure 2.7). Moving to the cloud can reduce storage and computing costs sharply per business unit and even create new business models across borders, but will also generate complexity. Companies are concerned that uploading manufacturing process and asset performance management data to the cloud may invite a myriad of information security and IPR problems. What’s more, a lack of awareness among many enterprises of the commercial applications of industrial clouds at the corporate level and a shortage of related capabilities all contribute to the lukewarm response to cloud deployment.

The choice between a public and private cloud depends largely on an enterprise’s focus. A public cloud is generally not preferred if the focus is just on production and manufacturing, as well as reducing cost and improving efficiency. If the focus is on business model innovation and product transformation, a public or hybrid cloud is the most common choice due to the likely involvement of service platforms and a degree of compatibility and integration requirements. With the focus on fundamental cloud-based capabilities among industrial clouds commonly deployed in China, a cloud is regarded as a virtual storage and computation server. Only a few enterprises have sought to change production modes and manufacturing ecosystems through cloud deployment. Enterprises deploying a public or hybrid cloud remain a minority.

Figure 2.7 Industrial cloud deployment

![Industrial cloud deployment](image-url)

- Not deployed
- Private
- Public
- Hybrid

Source: Deloitte Smart Manufacturing Enterprise Survey 2018
Deloitte sees three main types of IoT application scenarios for smart manufacturing: equipment and asset management, product insights and service innovation.

- **Equipment and asset management**
  The combination of a sensory and networking-enabled system and big data gives rise to a range of equipment monitoring and management capabilities, such as remote monitoring, predictive maintenance, and site interconnection. With the IoT replacing traditional manual inspection, remote monitoring can be performed using a sensor to transmit equipment data to the operation center. Predictive maintenance breaks the traditional planned maintenance mode on a regular basis, conducting full-range, lifecycle monitoring of equipment through the IoT. It can also predict possible equipment failures, with the ability to develop preventive maintenance plans to reduce the incidence of failure and improve production efficiency.

- **Product insights**
  The IoT can also connect and monitor industrial installations and equipment in a plant for analysis to help improve performance and efficiency across industrial equipment, production lines and the plant. Older plants or machinery also need to be monitored online before they are replaced. Enterprises are concerned about how to carry out IoT-enabled transformation work on existing equipment.

- **Service innovation**
  Post-market services are provided based on data and a platform. Business model innovation is achieved through the integration of IoT and services. The IoT enables manufacturers to capture and predict market needs more effectively, so they can create dynamic, individualized smart services, consulting services, data services, IoT finance and insurance and other new services. This application will break the confines of business operations, drawing attention to optimizing manufacturing resources from the overall perspective of society, customer-manufacturer interaction and business model innovation.

  Enterprises need to assess their business needs and define the scope of business objectives, associated processes and expected results. They also need to consider technology scalability, performance, bandwidth economy and the level of technological innovation before they can make an informed choice on data and IoT system processing architecture.

"In the future, a substantial part of added value will be derived from cross-enterprise activities. In the long run, public and hybrid clouds will become a dominant trend by virtue of being the only conduit for data exchange and resource sharing. Private clouds, albeit secure, are most likely to be marginalized from new business models and new ecosystems."

— He Dongdong, CEO of iRootech
2.4 Reshaping future business models

Smart manufacturing can not only help manufacturers achieve lower cost and higher efficiency, but also give them the opportunity to rethink their value proposition and restructure their business models. This makes even more sense at a time when new entrants are constantly challenging the incumbents. Many technology companies have joined the fray, driving manufacturers to explore business model innovation.

Our survey found roughly four different approaches to future business model planning. Of the enterprises surveyed, 30% expect to adopt a platform-centric business model, 26% mass customization, 24% a solution based on “products & services” and 12% a business model focused on IPR (Figure 2.8). The platform-centric business model is oriented towards providing multiple software services and ecosystem building. Although we are unlikely to see industry giants like Baidu, Alibaba and Tencent, there will be no shortage of vertically integrated industry leaders and platforms.

Mass customization like C2M is not confined to garment manufacture; it has extended to automobile and equipment manufacturing. Many enterprises are turning to a solution centered on “products & services” designed to meet customer needs. Enterprises focusing on IPR are well placed to dominate the market by erecting technology barriers with the patented technologies in their possession.

Each business model has different value positioning, value creation and challenges (Figure 2.9). Companies need to continually review business models, assess operations for improvements where appropriate and evaluate the viability of other business models regularly.

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**Figure 2.8 Future business model positioning**

- Platform-centric: 30%
- Mass customization: 26%
- Product & service-centric: 24%
- Intellectual property-centric: 8%
- Others: 12%

Source: Deloitte Smart Manufacturing Enterprise Survey 2018
### Figure 2.9 Characteristics and challenges of different business models

<table>
<thead>
<tr>
<th>Business model positioning</th>
<th>Characteristics and trends</th>
<th>Challenges</th>
</tr>
</thead>
</table>
| **Platform-centric**       | • Multiple software services + ecosystem  
• Competitiveness lies not in the platform per se, but in its ability to provide software services  
• Most enterprises will choose a more scalable public cloud platform to build infrastructure on  
• Vertically-integrated industry leaders and platforms are much more likely to emerge than industry giants Baidu, Alibaba and Tencent are  
• Typical players: GE Predix, Sany Heavy Industry, iRootech | • Industrial enterprises are more innovative with physical products than they are with software services  
• The software platform must support a variety of service solutions, including those yet to be developed  
• Data ownership  
• May require a series of software business acquisitions  
• As platform business development and incubation are time-consuming, management and shareholders need to ask if they can tolerate a relatively long payback period  
• It is difficult for platform businesses to compete with incumbents for human and financial resources. Business unit P&L restructuring and a change in accounting practices may be necessary |
| **Mass customization**     | • Oriented directly towards users and focused on multidimensional cross analysis, understanding user behavior and data model development  
• The modular design method is often used  
• Users, manufacturers and suppliers are connected through a data chain  
• Business processes share the characteristics of flexible manufacturing  
• Many industries, such as clothing, consumer electronics, automobiles and equipment manufacturing are likely to move towards mass customization  
• Typical players: Red Collar Group, Haier, Changan Automobile | • Budgets for customer interaction, data storage, data analysis and other technologies will rise sharply  
• Supply chain digital transformation is required to cope with demand for individualized customization  
• Cost levels and structures must be controlled as production becomes increasingly complex |
| **Product & service-centric** | • Provide a total solution based on the two major components of product and service  
• Service is an important component of product strategy and a source of profit  
• Service and product innovation in parallel  
• Typical players: Rolls-Royce, XCMG | • The shift from improving customer experience with existing products to new solutions meeting customer needs  
• System integration capability needs to be improved  
• Investment in innovation has surged, but the results have been less than satisfactory  
• Change in income model |
| **Focus on intellectual property rights** | • Enterprises tend to dominate the market by putting up technology barriers with the patented technologies in their possession  
• Sources of revenue: 1) Patent royalties; 2) a combination of patents, products and solutions; 3) technology transfer  
• Technology licensing often works in concert with standardization strategy  
• Typical players: Qualcomm, Huawei, Netac | • Large investment in technology research and development required  
• Uncertain timing of tech product commercialization  
• The main sources of revenue become less certain prior to patent licensing  
• A great deal of resources need to be channeled into safeguarding patent rights |

Source: Deloitte Analytics
2.5 Artificial intelligence

AI affects manufacturing in two main ways, by improving product quality and production efficiency in the processes of manufacturing and management and effecting total disruption of existing products and services.

Robots are widely used in domestic Chinese manufacturing and management, reflecting the increasing level of automation. AI further empowers robots with self-learning capabilities. By combining data management and introducing a network of automation and related equipment, robots can use machine learning and analysis to coordinate production lines precisely while more accurately predicting and detecting production problems in real time.

The application of AI in manufacturing products and services is even more disruptive. The product itself is an AI carrier, using hardware combined with a variety of software to produce sensory and judgment capabilities and the ability to interact with users and the environment in real time. The existing ecosystem also faces disruption by product and service functionality. In the automobile industry, for example, the competitive landscape traditionally resembles a pyramid—with total assembly plants above a hierarchy of suppliers. But, in the era of smart vehicles, total-assembly automobile manufacturers’ dominance will be severely challenged. Parts manufacturers, internet giants, algorithmic businesses, chip manufacturers and sensor suppliers, among others, are speeding up research and development and commercialization of autonomous driving technologies, aiming to tip the ecological balance of the industry from a position of high technological strength.

What is the status of Chinese manufacturers’ application of AI? Our survey found 51% of enterprises are using AI in manufacturing and management and 46% have deployed or plan to deploy AI to empower their products and services (Figure 2.10). The use of AI in manufacturing and management is more oriented towards system automation and lean manufacturing, with the aim of improving production efficiency and quality while freeing up human resources to address issues that are more complex. The main application scenarios include using robots to achieve process automation, flexible manufacturing, customized production and quality inspection. The use of AI on products and services is more focused on the interaction between products/services and users. Typical applications include R&D and new product testing, user behavior analysis and autonomous driving.

As AI is still in its early stage of development, technological breakthroughs and business cases will take some time to develop. Moreover, enterprises face major challenges from the robustness or otherwise of the AI application environment and infrastructure, information and security regulations and even their own business capabilities. We found the major challenges for manufacturers yet to deploy AI are the lack of a business case for investing in AI, absence of systematic capacity to build and support AI and uncertainty about the premise of AI deployment (Figure 2.11).
AI is rapidly penetrating various industries. More than half of automotive and auto parts manufacturers using robots has reached 80%, indicating other industries are the major source of future growth in the employment of industrial robots. The industries in which AI for products and services is deployed or planned are evenly distributed. Advanced equipment manufacturing and pharmaceuticals account for a relatively high share, but other industries including new materials, automobiles and auto parts, aerospace, electronics and electrical appliances are also deploying or planning to deploy AI.

Figure 2.12 AI application and deployment* (by industry)
China’s smart manufacturing: a steady push for the long term | II. Focus of Smart Manufacturing Deployment

"As far as the use of AI in manufacturing is concerned, applications are more equipment-related (e.g. logistics and product inventory management) than technology-specific."

—— Zhao Jinyuan, General Manager of Business Division 1 of Taiji Group IT Business and Service Group

The manufacturing industry’s understanding of AI has been growing with the development of algorithms, technologies and applications. Enterprises should look beyond the established notion of AI simply as “machines to replace humans” and start planning to deploy AI in areas such as lean manufacturing, product quality and user experience.

**Figure 2.13 AI application scenarios in various industries**

<table>
<thead>
<tr>
<th>Industry</th>
<th>Application scenarios</th>
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</thead>
</table>
| **Automobiles**        | • Smart production: automation combined with AI can improve production line efficiency and product quality  
                         • Smart in-vehicle systems: smart voice assistants, facial recognition, fatigue monitoring, navigation, man-machine interfaces, car-home interconnection and intelligent security  
                         • Driving aids: at the perceptual level, machine vision and speech recognition systems perceive the driving environment and understand passengers; at the decision-making level, machine learning and deep learning models are used to build driving decision-making systems  
                         • Smart sales: potential buyers learn about a new vehicle’s features and enquire about it through mobile APPs; mobile phone scanning to understand the problems of a suspected faulty control component or display screen  
                         • Predictive maintenance: collects real-time data and repairs or replaces parts and components in advance based on operation status information and predictive models  
                         • Automobile finance and insurance firms: combine AI with big data to assist in risk-related decision making |
| **Advanced equipment** | • Smart production: coordinate retrofitting and integration of robots and automated production lines to ensure the efficiency, safety and self-correction capability of discrete production processes  
                         • Intelligent equipment: Autonomous design and optimization of operating status, autonomous evaluation and optimization of energy consumption; evaluation and diagnosis of important systems and equipment; and autonomous perception of data and information about the equipment itself and the environment  
                         • Predictive maintenance: collects real-time data and repairs or replaces parts and components in advance based on operation status information and a prediction model |
### II. Focus of Smart Manufacturing Deployment

<table>
<thead>
<tr>
<th>Electronics and electrical appliances</th>
<th>Aerospace</th>
<th>Pharmaceuticals and life sciences</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Smart mobile devices: voice interaction, enhanced user experience, mobile AI chips</td>
<td>• Smart aircraft: autonomous design and optimization of operational status; autonomous evaluation and optimization of energy consumption; evaluation and diagnosis of important systems and equipment; autonomous sensing of data and information about the equipment itself and its environment</td>
<td>• Faster drug development thanks to a drug development platform combining AI, big data, bio-model analytics, genomics and other tools</td>
</tr>
<tr>
<td>• Smart home: revolves around features including intelligence, convenience and safety with a combination of smart home devices and a smart home platform</td>
<td>• Space station robots: support space station assembly/construction and spacecraft capture; assist astronauts in extravehicular activities, repair and maintenance, payload care and other intelligent space operations</td>
<td>• Pathological study: using AI to study genes, the environment and other factors to understand the pathogenesis of a disease and relative contribution of each factor</td>
</tr>
<tr>
<td>• Wearable devices: target different consumer groups with artificial intelligence and a variety of wearables, including wristbands, watches, glasses, headphones and clothing</td>
<td>• Autonomous sensing of data and information about the equipment itself and its environment</td>
<td>• Prevention and treatment of infectious diseases: Analyze and predict an epidemic by combining the time and location of all cases in local hospitals with multiple variables such as wind direction, humidity, temperature and population density</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Patient recruitment and identification: using machine learning to match patients with the most appropriate clinical trials underway</td>
</tr>
</tbody>
</table>

Sources: Public information, Deloitte Research
III. Bridging competency gaps

Restructuring a business model is a complex and daunting undertaking. In our survey, we asked companies to rate their capability gaps to realizing the business models they conceive. Taken together, optimization, innovation management and cloud deployment are three key tasks in corporate capability building. We suggest efforts to improve capability focus on the following areas:

Figure 3.1 Capabilities that need to improve (the higher the weighted score the weaker the capability)

Capability gaps in surveyed enterprises

![Capability gaps in surveyed enterprises](image)

Source: Deloitte Smart Manufacturing Enterprise Survey 2018

**Business model optimization**
Optimizing a business model may mean only changing or improving some of its existing elements, but can also involve a major transformation that changes the whole modus operandi. In the past 15 years, rapid advances in technology, communications, logistics and transportation, have made such drastic transformations more commonplace. To optimize its business model, an enterprise will need to adopt effective methods and tools targeting the following areas of operation:

- **Corporate transformation and reorganization:**
  An enterprise can improve its existing business model, including every part of the process from raw material procurement to product sale, and explore areas where optimization can produce a complete or partial change that supports a new business model.

- **Reconfiguring IT systems:**
  Enterprises need to explore, design and implement improvements to infrastructure and IT systems.

- **Re-staffing:**
  Making the most of human resources is one of the keys to the sustainability of corporate transformation. Re-staffing focuses on the design and implementation of new workforce deployment programs to support and enable a smooth transition to a new business model. Re-staffing also includes developing new key performance indicators and reporting lines to support the new business model.

- **Revamping legal, financial and tax structures:**
  The design and implementation of business model optimization often involves changes to a multitude of complex legal entities and tax structures. The management team of an enterprise needs to analyze the pros and cons of different approaches. Considerations may include income tax and transfer pricing implications and the potential impact of value added taxes and tariffs on the new business model.
Innovation management
Innovation management aims to optimize innovation product management, lifecycle costs, capital use efficiency and risk management.

- **Optimizing innovation product management:**
  Building a centralized product management system (covering tangible products and services), optimizing the decision-making process and improving its efficiency.

- **Optimizing lifecycle costs:**
  Product investment and operating costs are optimized through the optimal lifecycle operation of a product.

- **Enhancing capital use efficiency:**
  Product management and capital use efficiency are improved through monitoring, evaluation and KPI management.

- **Improving risk management:**
  Market, data security and other risks in the innovation process are managed effectively.

Pure product innovation management cannot sustain an enterprise’s competitive edge for long. Amid the fierce competition confronting almost all types of product today, the unique advantage of any new product can be lost overnight. A combination of different types of innovation can help companies achieve better financial returns. Although corporate success cannot be solely attributed to innovation, innovation helps improve a company’s mechanisms, thereby improving investors’ expectations for its future.

Cloud deployment
Simply transferring data and applications to the cloud is far from sufficient. In most cases, cloud utilization involves multiple business functions, with implications for suppliers, financial reporting and customers. Long-term plans need to be developed and implemented step-by-step. Enterprises also need to consider fully the extent to which human resources and digitalization can fit into cloud deployment.

- **Planning:**
  An enterprise needs to review its existing business model and explore viable alternatives as the basis for developing a cloud deployment strategy, based on business discussions, verification of the merits of deployment and assessment of its capabilities.

- **Execution:**
  The execution stage can be divided into four steps. Step 1 is SaaS deployment, covering ERP, CRM, human resources transformation and more software installation. Step 2 is individualized deployment, including application development, architecture building and platform deployment. Step 3 is cloud migration, most often involving the need to update and adjust application software. Step 4 is the introduction of a big data analytics platform.

As today’s markets diversify further, consumer needs are constantly changing and there is an irreversible shift towards digitization and smart applications in products, production processes and services. Given this dominant trend, industrial enterprises are not only speeding up smart manufacturing deployment, but also constantly reviewing business models and formulating effective strategies, aiming to drive real-value creation at the operational and strategic levels.
Endnotes


Note 2: Millions of SE Asian jobs may be lost to automation in next two decades: ILO, 2016-07 https://www.reuters.com/article/us-southeast-asia-jobs/millions-of-se-asian-jobs-may-be-lost-to-automation-in-next-two-decades-ilo-idUSKCN0ZN0HP


Note 4: “Singapore will spend $107m to be a force for AI in the next 5 years”, Tech in Asia, 2017-05-04, https://www.techinasia.com/singapore-aisg-startups

Note 5: “Industry 4.0 Maturity Index”, Acatech, http://www.acatech.de/fileadmin/user_upload/Baumstruktur_nach_Website/Acatech/root/de/Publikationen/Projektberichte/acatech_STUDIE_Maturity_Index_eng_WEB.pdf


The Survey covered 153 large and medium-sized enterprises, grouped as either manufacturers or technical service providers. The manufacturers are involved in a variety of industries, including automobile, equipment, electronics and electrical appliance and aerospace manufacturing. The technical service providers are further divided into technology providers and solution providers. Technology providers cater to manufacturers’ need for industrial IoT, big data, AI and industrial APP technology. Solution providers offer customers total solutions integrating hardware, software and services.

**Surveyed enterprises by type**

- Manufacturers: 59%
- Technology providers: 20%
- Solution providers: 21%

Source: Deloitte Smart Manufacturing Enterprise Survey 2018

**Surveyed enterprises by industry**

- Advanced equipment manufacturing: 26%
- New Materials: 7%
- Others: 5%
- Electronic components and electrical appliances manufacturing: 23%
- Aerospace: 22%
- Automobile and auto parts: 21%
- Pharmaceuticals: 10%

Source: Deloitte Smart Manufacturing Enterprise Survey 2018

**Surveyed enterprises by ownership**

- State-owned or state-controlled: 53%
- Private: 18%
- Foreign-funded: 29%

Source: Deloitte Smart Manufacturing Enterprise Survey 2018

**Respondents by job position**

- CEO: 35%
- CTO/CIO/Head of technology: 23%
- CMO: 15%
- Head of strategy: 12%
- Head of products: 12%
- Others: 3%

Source: Deloitte Smart Manufacturing Enterprise Survey 2018
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