

Technology Innovation and Industry 4.0: Opportunities and Challenges in Chinese Industrial Development in 2016

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Currently, Chinese industrial development is at the special and critical moment of global economic cycles. New industrial reform starts to happen where industrial development faces serious technological changes and fundamental changes occur in mode of production and pattern of consumption. Economic cycles and technological changes provided for Chinese industrial development the opportunity to “overtake around curves,” as well as severe challenges for improving industry energy level. In the future, Chinese industrial development will face both opportunities and challenges.

In the long term, the supply and demand changes driven by technological innovation directly determine the future direction for industrial development. With the change of mode of production and pattern of consumption, industrial development will show a series of new trend like personalization, intellectualization, modularization, connectivity, mass customization and so on.

In the short term, in terms of demand, the motive force of industrial development gradually moved from investment-driven to consumption-driven. This will not only bring the industrial structure changes, but also improve industry energy level. While in terms of supply, government intensifies efforts in policies to lead the industry energy level improvement and actively promote the integrative development of traditional industries and emerging industries, which will help the industry transformation become much faster.

However, the industrial transformation is a battle to burn Chinese boat. Domestic industrial transformation is bound to cause the reconstruction of international industrial specialization. In high-end industry, China will compete against developed countries to seize higher position in value chain, while in low-end industry, industrial transformation will close down backward production facilities gradually and speed up to transform low-end industry to newly emerging developing countries. Therefore, Chinese industrial transformation is an arrow left by, which if it failed, domestic industry would be at the risk of hollowing out.

1. New industrial revolution is speeding up. Technological reforms rebuild the mode of production and pattern of consumption.

In the future, Chinese industrial development will face both opportunities and challenges. Industrial development will show a series of new trend. Domestic industrial transformation is bound to cause the reconstruction of international industrial specialization.

After the financial crisis, the global economy has entered the historical period of rotation of old and new economic cycles. The rotation of the economic cycles also foreshadowed the new industrial revolution. The essence of new industrial revolution is the integration and innovation of technology like NGIT, new material and energy. In this trend, great innovations such as NGIT, robotics, 3D print and new material technology keep emerging and become mature.

NGIT is the core of this industrial revolution. Traditionally, internet and information technology was only the tool for person to person communication. With the integration of connectivity, digitalization and intellectualization, NGIT represented by new generation of communication network, internet of things and cloud computing will become more mature, keep infiltrating different links in manufacturing industry and finally the whole industry chain, lead new series of production, service, production system and industry and create new developmental pattern instead of the old technology economic pattern.

New material technology is the basis of this industrial revolution. The new generation of production materials will choose CNT, ceramic nano composites, new carbon fiber and other new materials to make the future production tougher, lighter, more energy-saving and more durable. Meanwhile, new material technology will completely change the mode of production from traditional reductive to additive production, with one-step building and precise manufacturing which greatly reduce time and cost for production and manufacturing.

New energy technology is the important safeguard for sustainable development in industry. In the current developmental mode of industrial economy, people's production and lifestyle basically depend on the production and use of fossil energy. However, people have gradually depleted the fossil energy, which makes the question of new sustainable production and living energy and power become the important revolution center. The new energy technology represented by solar, wind technology, ocean and nuclear power technology is now playing the role, taking place of the original industrial structure and production. Besides new energy to generate electricity, new application fields like new energy vehicles or houses are becoming the essential consumer goods.

New technology represented by information technology, new energy and new material is becoming more and more mature. In the long-term, technological changes will lead the change of mode of production and pattern of consumption in the end, and then affect the direction of industrial development.

1.1 Personalization, integration and facilitation have become new trend of

consumer demand.

New technology makes diversified consumer demand possible. There are new trends in consumer demand.

First is the personalization in consumer demand. With increasing income level, consumers prefer to consume in their own ways, while the traditional service industry system featured with standard products and service cannot satisfy consumers' need for personalization in the future. In fact, it is the consumers' specific demand information and data that are behind the personalized need. Big data of consumer demand is the result of huge number of consumers, different information because of different individual need and continuously changed need. Traditional technology is not powerful enough to deal with big data of consumer demand, but with information technology develop and big data technology become mature, consumption big data become more and more important. Dealing with these big data, sending to smart device to do the calculation, then adjust equipment, prepare material, continue automatic processing and finally produce the productions that meet the personalized demand.

Personalized demand has shown its effect in China. Through e-commerce platform, consumers can buy T-shirts and with their photos on them, or bottles and pencil vases with their own names, or simple fashionable handbags and ornaments with their own LOGOs, or custom-made classic furniture. In the future, the trend of personalized demand will become more and more dominated.

Second is the integration of consumer demand. Consumer demand is personalized as well as diversified. To have the best customer experience, consumers wish that manufacturing industry and service industry can offer package solution based on personalized and diversified consumer demand, which save the search time and cost for consumers realize effective coordination between productions and service to provide more accurate and better service for consumers.

The rapid development of Internet industry offers effective solution to the integration of demand. No matter "platformization" or "conceptualization," the commercial design approaches are ultimately the basic requirements for the integration of consumer demand. It is not rare in Internet industry. For example, Tencent treats instant message as the entry of scenario and creates multiple communication, entertainment, shopping and finance platform around the basic demand of consumer communication. Alibaba treats shopping as its entry of scenario and creates the ecological empire containing online shopping, Internet finance and logistics service around the basic need of consumer online shopping to satisfy the integration of consumers. In the future, the influence of

integration of consumer demand will keep growing, further expand to traditional industry and replace completely traditional manufacturing and service industry system.

Third is the facilitation of consumer demand. Consumers always want to consume in the most facilitated and the most energy-saving way. No matter how deep or complicated the technology is, it always appears in front of consumers in the simplest form, because the technology and channel are only methods for consumers, not final goals. Meeting their demand is the final requirement to consumers.

Therefore, traditional industry or newly emerging industry, to satisfy the facilitation of consumer demand is the basic premise of industrial development. Nowadays, O2O has become the mainstream of pattern of consumption, mainly because it dynamically integrates easy accessibility of online products service and the convenience of offline products service experience, to create a more convenient path than single pattern of consumption, which is favored by consumers. In the future, the trend of facilitation of consumer demand will generate more opportunities for industrial innovation.

1.2 Intellectualization and mass customization lead new revolution for mode of production.

The present mode of production is machine to machine and mass standardized production, which gradually shows the shortcomings and cannot meet the new need for industrial development. Currently, the intelligent mass customization supported by Internet springs up and developed in many ways.

The center of new production mode is smart manufacturing. Smart manufacturing is based on automatization, connecting different equipment through data interaction by internet of things, information and communication technology and big data analysis, and make a whole of outside and among the factories.

Driven by smart manufacturing, productions, equipment and management will form an organic whole of self-coordination and self-adjustment. Each production will have all kinds of information of the whole supply chain and life cycle. The equipment can realize self-organization taken by the complete production value chain. The management can determines the production process flexibly according to the current situation. Manufacturing system is composed of 6C: Connection—sensor and Internet, Cloud—data from any time or for any need, Cyber—mode and memory and Customization—customized service and value.

The productions under 6C are actually the integration of function and

data, with function to be used and the vehicle of information. Productions can record everything automatically during their production process. Meanwhile, they can help operation and monitoring around environment. For an instance, a product will change according to outside temperature and humidity after it comes out of the factory, and automatically remind supervisors to do what kind of extra adjustment actions.

Factories under 6C can realize smart manufacturing in the chain and the self-adjustment in production. In 2013, PiWeb of Zesis Group in European machines actually reflects above theory. PiWeb can collect measured data by machines in factories of different links of chains and from different areas. In the future, the collected information can figure out automatically how to adjust through systemic analysis and send back to different factories to realize real-time intelligent adjustment.

The management under 6C can realize transparent production and predicted production. There exist many potential unpredicted factors in present manufacturing including the decreasing capacity in processing procedure and occasional loss efficacy of components, scrap and reworks and decreasing effectiveness of the whole equipment. Through transparent with, elaborating and quantifying those uncertainties, production organizers objectively evaluate their capability of manufacturing and equipment, realize predicted manufacturing to reduce cost of maintenance, to improve the operation efficiency and to improve the production quality.

Intelligent mass customization has three ways to develop technology. The first way is 3D print, which can meet the personalized need because of separate print. However, a lot of obstacles in print materials and low printing speed prevent the widespread use of 3D print technology. In the long term, 3D print is bound to cause great changes in manufacturing industry. The second way is industry 4.0. The system is based on the internet of things and Internet, as well as the combination of cyber and physicality, which is a production system able to mass customization, quite different from traditional mass standardized mode of production. The third way is the integration of modular division to divide productions into modules according to functions and combine them according to need to satisfy personalized consumer need.

2. The driving force of industrial development has moved to consumption-driven to drive industrial structure transformation.

In short term, domestic industrial development is now under rebalancing, where driving force moves from investment-driven to consumption-driving. The rebalancing will not only bring three changes in industrial structure, but also promote the industrial energy upgrading.

2.1 Consumption-driven gradually dominates. The proportion of service industry keeps rising.

After the financial crisis, Chinese economic development has new changes. The economic development has entered into "New Normal," from high-speed growth to medium-high speed growth, where the effect of investment-driven economic growth gradually is replaced by the influence of consumption-driven growth. In three quarters in 2015, total social retail sales of consumer goods increased steadily, with 10.5% year on year, in which total online retail sales increased 36.2% year on year. Consumption increases faster than investment and net export. Consumer spending accounts for GDP growth for 58.4%, with a year on year increase of 9.3 percent, 15 percent more than investment contribution rate. Consumption has become the dominated driving force of economic growth.

The change of the consumption-driven economic growth is also promoting the transformation of industrial structure, with the increasing proportion of tertiary industry. Up to September 2015, the added value in tertiary industry increased to 51.4%, accounting for domestic economy more than 50%, increasing 2.3 percent year-on-year. Industrial structure gradually moves from industry-dominated towards service industry dominated.

The three industry structure is still waiting for transformation. Based on the experience in developing countries and regions, the proportion of tertiary industry can be up to 70% of GDP. Thus it can be seen that the future position of tertiary industry will be promoted, and the influence of consumption will be enhanced.

2.2 The increase of quantity brings the improvement of quality. Consumption upgrading promotes increase of capacity.

With the increase of consumption volume, the position of consumption keeps being promoted. Consumption not only increases the speed of industrial development, but also determines the direction of development. The future industrial development will pay more attention to the trend of consumer demand. Personalization, integration and facilitation of consumer demand upgrading will force domestic industry to upgrade and restructure.

To meet the personalization, integration and facilitation of consumer demand, we cannot forget the development of technology and fully developed industry. The rapid development of consumption will attract more and more enterprises to actively lead transformation, to use new technology, to realize energy level upgrading and meet the change of demand. The data of three quarters in 2015 show that though economic

growth faces downward pressure, industries like high-tech industry still grow and new industry, new formats, new productions, new economy and other new growth keep generating and emerging and become one of the highlights in 2015 economic development. From January to September, the online retail sales increased 36.2% year-on-year, of which the physical goods increased 34.7%, faster than traditional retail industry. The increasing speed of added value in high-tech industry is up to 10.4%, 4.2 percent higher than the increasing rate of industrial enterprises above designed size.

In the future, there will be more new technology generated by consumer demand upgrading. Newly emerging industries use new technology to produce new productions and open new markets. Traditional industry use new technology to refresh old technology and create new node. Under this circumstance, domestic industry will realize the transformation of industrial structure and upgrading of industrial energy level.

3. Intensified efforts in government policies to accelerate the integrated development of industrial innovation.

The Central Leading Group on Financial and Economic Affairs proposed in November that the focus on government policies will be shifted from demand to supply. In fact, China is strengthening the policies in supply and need. The two guiding documents: “Made in China (2025)” “Notice of the State Administration of Taxation on Issuing the Action Plan of ‘Internet + Taxation’” offer definite direction and clear path for industrial development of innovation and integration.

3.1 “Made in China (2025)” plan makes the direction of development of intelligent manufacturing clear.

Manufacturing is the main part of national economy, foundation of the country, the way to make nation prosperous and powerful. Nowadays, new scientific technology revolution, industrial changes historically intersect with Chinese accelerating the transformation of development pattern, which provides an excellent historic opportunity for Chinese manufacturing transformation and upgrading. During this critical period in history, the national development planning “Made in China (2025)” clarifies the wonder and indicates the direction for domestic industrial development.

It is planned that the ultimate goal of Chinese manufacturing development is to become the leading manufacturing power. The government proposed the steady “three step” strategy. The first step is to enter the ranks of manufacturing power up to 2025. The second step is to improve national manufacturing level to the average of the global manufacturing power.

The third step is to strengthen the position of manufacturing power and improve the comprehensive strength to the leading global manufacturing power to the 100th anniversary the founding of New China.

Guided by “Made in China (2025)”, our smart manufacturing will face unprecedented development opportunities. NGIT, high-end devices, new energy, new material, biomedicine and other strategic industries will enter the channel of rapid development.

In the future, NGIT will be deeply integrated into manufacturing. 3D print, mobile internet, cloud computing, big data, bioengineering, new energy, new material and other fields make new breakthroughs and are used widespread. Manufacturing industry will form new mode of production, industrial form, commercial mode and economic growth point. Smart manufacturing based on intelligent devices and factories in cyber-physical system will lead changes in manufacturing mode. Crowd-sourcing web, collaborative design, mass customization, precise supply chain management, complete life cycle management, e-commerce will reform the industrial value chain system. Wearable smart things, smart home appliances, smart cars and other smart terminal products will continuously expand new fields for manufacturing industry.

3.2 “Internet plus” initiative created a clear path for industrial integrated development.

NGIT not only can restructure and upgrade traditional manufacturing industry, but also with its actual much wider range of application, can deeply integrate with different economic and social areas to push forward the technological development, improvement of efficiency and structure revolution, to improve innovation and productivity of entity economy. The “Internet plus” initiative proposed by the government just hits the trend accurately, make clear the industrial path for integration of Internet and other areas and innovation development, which is significant for Chinese economic quality improvement and upgrading.

In the future, Internet will deeply integrate with modern agriculture, improve the production, operation and management level of agriculture to form network, intelligent and fine modern “planting, breeding and processing,” the new pattern of eco-agriculture. Internet will deeply integrate with smart energy to promote the flattening, web-based energy system, to push forward the energy production and mode of consumption revolution, to improve the utilization efficiency of energy and to save energy and reduce emissions. Internet will deeply integrate with financial service. The integration and innovation with banks, securities, insurance and fund, shall provide various safe convenient financial products and service, to better satisfy investing and financing requirement of different

levels, and to form some of the Internet financial innovated enterprises with great influence. Internet will deeply integrate with benefiting people service to create new service like medical treatment, health, pension, education, tourism and social security based on Internet, which can improve utilization efficiency of resources and reduce service and consumption cost. Internet will also deeply integrate with logistics service to create cross-field and cross-border logistics information service platform. The platform can improve the efficiency of logistics supply and need information connection and utilization. Big data and cloud computing are widespread used to improve the automation, smart level and operation efficiency of logistics storage and reduce the logistics cost. Internet will deeply integrate with ecological construction to form network to dynamically monitor the resource and environment caring capacity covering main ecological elements to realize the connectivity and opening sharing of ecological environmental data to promote the easy access to the recycled resource trading, the interaction and the transparency, and to promote the greening of lifestyle and mode of production.

4. International industrial distribution faces restructuring, while Chinese industry faces the challenge of hollowing out.

Under the circumstance of global industrial revolution, not only China faces great pressure of industrial transformation and upgrading, the whole international industrial systems are also experiencing turbulence and changes. Chinese industrial structure transformation is bound to happen with national industrial division reconstruction. Chinese industrial development is between the attack of the traditional developed countries and newly emerging latecomers.

4.1 USA and Germany taking advantage of traditional industry, occupy high-end industries from software and hardware.

One of the earliest countries to develop CPS is USA. The essence of CPS is to combine the industrial big data, their information system and American own Silicon Valley type, to make sure the American leading position in the future smart manufacturing. This is also one industrial strategy to occupy the high-end industry from the side of software.

USA have built a set of innovative tools to make predictions about the uncertain information based on the things collected by data system, which can help managers be more “informed” when they make up their minds to realize part of transparent productions. The set of tools include integration, predictions, analysis and visualization. For example, the algorithm in the software called Watchdog Agent™ is divided into four parts: signal processing and feature extraction, health assessment, performance prediction and failure prediction. With the help of radar map,

fault graph, risk map and health deteriorating curves, the software can send the information of factory equipment effectively to realize the smart production.

However, Germany tried the opposite way of USA: the side of hardware. In 2011, Germany proposed the idea of “Industry 4.0,” which focused on the construction of smart factories. The interconnected smart factory system created through the national strategic cooperation and the advanced manufacturing equipment industry make Germany become the pioneer of new industrial revolution.

DFKI along with 10 Germany enterprises built the first factory model reflecting “Industry 4.0” in the world. 10 cooperative partners connected by the program called Smartfactory individually created one system mode or offered related cross-application technology. The model shows the process where innovative cooperation and work among enterprises from different fields translate the idea into goods and the wish into reality. The model is an example of organization of production under 6C.

	Germany	USA
National Advantages	advanced manufacturing machines	software and information system
Development themes	smart factory	smart manufacturing
Specific operation	under the nation to develop experimental smart factory and equipment in cooperation	to encourage the development intelligent monitor software and to study the corresponded big data and data application
Examples	Smartfactory mode	Watchdog Agent™ software

Figure 4.1 The paths of new industrial reform in Germany and USA
 Source: Rui Mingjie, 2014.

Chinese industries develop smart manufacturing and transfer to high-end industry, which will definitely compete against Germany and USA.

4.2 Newly emerging countries taking advantage of cost, actively attract the transfer of labor-intensive industries.

Behind the active transformation of industrial structure to high-end industry, the labour-intensive low-end industries face less and less preferential policies. At the same time, the end of demographic dividend directly increases the labour cost. According to the “Report of Global Manufacturing Cost Change” released by the Boston Consulting Group,

if we set the American manufacturing cost as 100, Chinese cost reached 96, only 4 point lower than America. It is obvious that low cost is no longer the competitive edge for Chinese industry, in the future the labour-intensive industries that seriously depend on cheap labour cost must be shut down more quickly to transfer to new latecomers.

In fact, the industrial transfer of low-end industries is happening. Take the example of Japanese and Korean foreign-owned enterprises, they started to withdraw from Chinese textile, footwear and jewelry processing industries after financial crisis. According to the data from KOTRA and Export-Import Bank of Korea, the number of Korean enterprises with new legal persons in China decreased from 1301 in 2008, 901 in 2010 and finally to 817 in 2013. Korea-invested enterprises, mainly in Shandong Province, are now decreasing with the rate of 500 every year. Japan-funded enterprises show the same trend. In 2005, there were about 2000 Japan-funded enterprises, which now decreased to around 1000. India, South-east Asia and other countries with low cost have become the new attraction to labour-intensive foreign-owned enterprises. Panasonic, Samsung, LG and other enterprises continuously established their factories in India and made fully use of the low labour cost there. Even many Chinese enterprises come to India. Any Heavy Industry, Weichai Power, Haier Electronics and some chemical enterprise began to build production base in India, while Huawei, MIUI, GiONEE and other communication and handset makers also actively make plans to build factories in India. The trend that low-end industries and links transfer to low cost countries is irreversible. In the future, with the implementation of “One Belt and One Road” initiative, there will be more low-end enterprises quitting Chinese market and entering newly emerging market. It is the initiative selection of Chinese industrial transformation and upgrading, the logical result of industrial energy level upgrading.

However, we must also realize that Chinese industrial transformation upgrading is an irreversible process, which means that transformation is battle to burn our boat. In the field of high-end industry, China will directly compete against developed countries in the value chain of smart manufacturing. For the low-end industry, industrial transformation will gradually put an end to outdated production facilities and speed up the withdrawal of low-end industries, which will make blank space in some of the areas within such short time. Apparently, it is a difficult process with many risks. Once it fails, domestic industry will at the risk of hollowing out, which is the biggest challenge in Chinese industrial development.

5. Conclusion

Chinese industrial development and industrial adjustment is a significant aspect in supply sector. We think we should insist on the general thinking

of deepening the market reform and industrial separated adjustment and take differentiated strategies to industries in different industrial life cycle and areas belonging to different grades. Traditional basic industries should be upgraded and rebuilt to cultivate and support new industries and promote the integrated development of Internet industries. We should steadily adhere to industrial transformation in east areas, keep industrial undertaking in west areas and continue the industrial upgrading in northeast region.

During the process of adjustment, the market should play the dominated role with the timely and proper guidance of government. There is a clear sequence of industrial adjustment, where stock adjustment comes before and incremental adjustment comes after. We should concentrate on supply system reform and play a principal role of enterprises in industrial transformation and upgrading from the aspect of financial, fiscal and tax, talent reform. Improve the market environment and counter monopoly to clear away obstacles for SMEs innovative development. Play the pivotal role of helmsman enterprises, in the direction of strategic new industry and grasp the helmsman enterprises to cultivate some enterprises and industries with the control of value chain.

We should look forward to the future. Chinese industrial development faces opportunities and challenges. In the long term, the change of supply and demand caused by technological reform directly determines the future direction of industrial development. With the change of mode of production and pattern of consumption, industrial development will have a series of new trend of personalization, intelligence, modularity, connectivity and mass customization. In the short term, the driving force of industrial development moves gradually from investment-driven to consumption-driven. It not only brings industrial structure change, but also improve the industrial energy level. The increasing national policy support strongly leads the industrial energy improvement, actively promotes integrated development of traditional industries and new industries, which will accelerate the industrial transformation development.

However, Chinese industrial transformation will cause the reconstruction of international industrial division and make domestic industries at the risk of hollowing out. In high-end industry, China will compete against developed countries face to face to control the high end in value chain. For low-end industry, industrial transformation will gradually close down the outdated production facilitation. Low-end industries will speed up to transfer to emerging developing countries. Therefore, Chinese industrial transformation is bound to be a battle to burn our boats.

Translator/Shi Ying